NATIONAL AEROSPACE PLANE (NASP) FISCAL YEAR 1992 RDT&E BUDGET REQUEST

JOINT HEARING

BEFORE THE

SUBCOMMITTEE ON
TECHNOLOGY AND COMPETITIVENESS

OF THE

COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY

AND THE

SUBCOMMITTEE ON RESEARCH AND DEVELOPMENT

OF THE

COMMITTEE ON ARMED SERVICES
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NATIONAL AEROSPACE PLANE (NASP) FISCAL YEAR 1992 RDT&E BUDGET REQUEST

TUESDAY, MARCH 12, 1991

U.S. HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY, SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS; COMMITTEE ON ARMED SERVICES, SUBCOMMITTEE ON RESEARCH AND DEVELOPMENT,

Washington, D. C.

The subcommittees met, pursuant to notice, at 1:30 p.m. in room 2318, Rayburn House Office Building, Hon. Tim Valentine [chairman of the Subcommittee on Technology and Competitiveness] presiding.

Mr. VALENTINE. Ladies and gentlemen, we will get started. We have a number of witnesses and we have some of their schedules to try to work with.

Let me say at the beginning, without objection, permission is granted for coverage of this hearing by television, radio, and still photography. This is a joint meeting, and Mr. Dellums, Chairman of the Armed Services Committee on Research and Development, has been delayed. When he comes in we will defer to him for his opening remarks and to chair the meeting.

Today we join, as I said, with the Armed Services Subcommittee on Research and Development to review the status of the National Aerospace Plane Program. It is now several years into its technology development and design definition. It is critical that we keep a tight discipline on this program so that the Phase III decision to build the X-30 in 1993 presents no unaddressed or unresolved problems.

The well of high performance aeronautical technology has run dry. Aeronautics today is largely limited to airframes and engines of 1950s vintage technology, perhaps "hi-fi"ed, so to speak, to a degree.

The National Aerospace Plane Program is conceived to correct this 30 year lapse, as well as to bring new and more powerful U.S. technical muscle to our industry, to the military, and to the U.S. international competition arena. The NASP demands a significantly higher technology level than, for example, the Sanger or Hermes concepts.

NASP or X-30 technology will span the entire aeronautical envelope through all reaches of the earth's atmosphere into space. The atmosphere that supports our earthly air transport, the atmosphere that will always be here, the atmosphere that is the near-nemesis of the space program.

The solution is to return to basic aerodynamics and enjoy one to two orders of magnitude improvement in efficiency over our current practice that is locked into rocketry.

The NASP is for the 21st century. One, it revitalizes the best elements of the Research Airplane Program that served us so well after World War II all the way to Desert Storm.

Secondly, it will provide true experimental data allowing derivatives to fly from a runway on earth to any orbit, with facility, flexibility, and economy. No such improvement is envisioned in current space programs.

Three, the NASP industry teaming concept proves we can compete as a country with the world rather than having a single company compete on behalf of America under historic rules that seem to favor our competition.

And, fourth and finally, NASP teams the best aeronautical resources that NASA, the Department of Defense, and the aerospace industry have to offer. This gives us the military/government/ industry complex at its best. And both DOD, NASA, and industry forecast tremendous long term dependence upon this investment in the future.

The Administration has recognized this Presidential Initiative as one of the keys to forestall our lapsing into a second class reactor to international initiatives.

The aggressive interest and investment in the NASP Program shown by the U.S. aerospace industry is unparalleled and demonstrates the mood and need for such a venture. The aggressive interest in the NASP Program shown by all of the industrial nations of the world, from Japan to all of Europe and the USSR, proves the wisdom of our choice of how to stay in and win the race in U.S. style. They all, understandably, want in.

We assemble today in a unique unison with our partners from the Armed Services Research and Development Subcommittee to demonstrate the national character of the NASP. And I recognize at this time the ranking Republican member of our subcommittee, Honorable Tom Lewis, from the state of Florida.

Mr. LEWIS. Thank you, Mr. Chairman. The National Aerospace Program has had many highs and lows since it officially began in 1986 in terms of program support by the Administration. This may be one of the higher highs.

The Department of Defense testimony starts out with a strong commitment. The NASA statement concludes with "NASA remains very strongly committed to NASP." And the President's Science Advisor advocates, "I would be strongly in favor of moving forward to Phase III."

I hope this hearing signals a start of a united front of support by the Administration for the NASP Program. For the first time that I can remember the civil and military benefits are clearly pointed out. Nevertheless, I hope to explore the reasoning for this strong support in the questions and answers segment.

Finally, for those who are new to the NASP Program, I want to point out that the largest positive balance of trade occurs in the aerospace segment of the United States trade. It is estimated that in 1990 that the aerospace industry trade surplus was $20-$25 billion. That is due to the U.S. lead in technology, which in turn is due in part to long term, high risk research programs such as NASP.

All Americans benefit economically from our technology in aerospace. The research funds we are talking about here today will pay dividends many times over.

I welcome our witnesses here today and look forward to hearing their testimony. Thank you, Mr. Chairman.

Mr. VALENTINE. Thank you. The Chair recognizes at this time Honorable Dave McCurdy, a distinguished member of this subcommittee from the state of Oklahoma.

Mr. MCCURDY. Thank you, Mr. Chairman. As a Member of the Research and Development Subcommittee of Armed Services and the former Chair of the TAM Subcommittee, I want to welcome these witnesses again. And I also want to commend you and Mr. Lewis for your continued interest and support of this program. It was a pleasure the two years that I chaired the TAM Subcommittee to have a working relationship with Mr. Lewis that I think was not only beneficial to the subcommittee, but that built a lasting friendship, and I appreciate his total support in this area.

The National Aerospace Plane is clearly at the cutting edge of advanced technology, as we all know, and I believe it will lead this Nation and the world into the 21st century. The progress of the NASP Program throughout Phase II is remarkable, particularly in three areas: In materials, to withstand the enormous temperatures; in air-breathing engines that will reach speeds of Mach 25; in an airframe design that will enable the U.S. to set the world pace in our hypersonic technology.

This type of innovative research into design to put an experimental, single-stage-to-orbit, air-breathing aircraft in space before the end of the century has already benefitted numerous other research and development aerospace programs. This spinoff technology can spur our economy by strengthening America's status as the world's premiere exporter of aerospace technology.

In July 1989, as a result of the National Space Council Review, President Bush approved a policy to "continue the NASP Program as a high-priority national effort to develop and demonstrate hypersonic technologies with the ultimate goal of single-stage-to-orbit." The President promised to continue DOD participation—and I underline that, Jack, and others— to continue DOD participation and to complete the Phase II technology development program and plan to develop an experiment flight vehicle after the completion of Phase II, if technically feasible. We are gratified to see the White House again demonstrate it's firm support for NASP by listing it as one of five Presidential Initiatives in the fiscal year 1992 budget.

Having sat for many years as a member of both of the subcommittees which are convened in this joint hearing today, I would have to count myself as one of the stronger NASP advocates. So it is with some degree of personal pride, and a great sense of national obligation, that I welcome these gentlemen who come before us to testify on the history and the status of NASP. Your leadership in each of your fields is extremely valuable to the goals and objectives of the National Aerospace Plane.

I would also express my hope that during the course of today's hearing each of you reflect on the President's unequivocal support for NASP.

Thank you, and, Mr. Chairman, again, I look forward to the testimony.

Mr. **Valentine**. Thank you, sir. We have, as I stated at the beginning, a number of witnesses we'd like to accommodate and I would at this point maybe vary from what has become routine. Is there any other member on the Republican side who would like to make some opening statement? Not any member on the Republican side? Mr. Rohrabacher, of California.

Mr. **Rohrabacher**. Just a very short statement.

Mr. **Valentine**. Yes.

Mr. **Rohrabacher**. I get the message, Mr. Chairman, I'll try to keep this very short. Let me just say that I believe that whatever nation has the National Aerospace Plane technology will be the nation that dominates the aerospace industry as a whole in the future. I mean, whoever has National Aerospace Plane technology will be the number one power in space and will be the number one power in the air in the next century. And that's what we're talking about, a commitment today as to whether the United States of America will indeed be the predominant world power in air and in space in the next century.

And far too often I'm afraid that decisions are made in this room, and also by the American industry, based only on what's going to happen for the next quarterly dividends or for the next budget session. And very few people are planning for the next century rather than for the next year's budget. And that's what we're trying to do today is keep America number one.

And I personally represent an area where the aerospace industry is so important to our people. And it's also very easy for me to support the National Aerospace Plane Program because I believe it is so important for the next generation for aerospace workers. But, again, it's also important for the United States of America. It's not just a regional or parochial interest. It's an interest in our country because unless we are the leader in aerospace technology, we won't be the leader in anything in the future.

And one last note, and I'll just say this. I was in Hanoi in December and I was talking to the Foreign Minister of that country, Foreign Minister Tak, and I had related to his deputy the night before how we were developing a new craft that would make it possible to fly from Los Angeles to Saigon — I think I used the word Saigon instead of Ho Chi Minh City — in a matter of an hour. And when the Foreign Minister saw me the next day, he said, "I heard about your new airplane." And he was very excited about it. And he said, "Does that mean that we can actually get in an airplane in Los Angeles, and you could get in the plane and come to Vietnam and then return by that afternoon?" And I said, "No, that means that you could actually get in the airplane in Los Angeles, do business in Vietnam in the morning, and come back for lunch." And his eyes lit up. And of all the issues we discussed, of all the things that were going on in the Gulf, nothing impressed him more than the power of this technology.

And as we enter into the Pacific era—and we are—and all this change is going on in the Soviet Union, they've let people think that perhaps we are not really entering into this new Pacific era that everyone was talking about 10 years ago. But the fact is the major upswing in humankind is going to take place in the Pacific. And I believe that the National Aerospace Plane will be an intricate part of the creation of this new era in the Pacific because it can cover such vast areas in such a short amount of time and do so economically.

So I am very pleased to be here. And, Mr. Chairman, I want to applaud you for the leadership you've shown on this issue because it is indeed something that is so important for our country, and you've shown such personal interest and support for the National Aerospace Plane Project yourself. So, thank you very much, Mr. Chairman.

Mr. VALENTINE. Thank you, Mr. Rohrabacher. Panel Number I consists of the gentlemen seated here in front of us: Dr. Allan Bromley, Assistant to the President for Science and Technology and Director of Office of Science and Technology Policy; Dr. James R. Thompson, Jr., Deputy Administrator, the National Aeronautics and Space Administration; Dr. Charles M. Herzfeld, Director of Research and Engineering at DOD; and the Honorable John J. Welch, Jr., Assistant Secretary for Acquisition of the United States Air Force. Welcome, gentlemen.

We encourage you to summarize if you possibly can. Your statements as presented to the subcommittee will appear in the record in total. If you could accommodate us by limiting your testimony to five minutes, it would be greatly appreciated.

I understand that Dr. Bromley has an urgent meeting after this. So when you feel that it's time for you to leave, you have our permission to depart. We will send you a list of questions or otherwise give you a pop quiz of some kind, maybe, to make up for that deficiency.

Dr. Bromley?

[The prepared opening statements of Messers. Valentine and Dellums follow:]

HON. TIM VALENTINE, CHAIRMAN
TECHNOLOGY AND COMPETITIVENESS SUBCOMMITTEE

NASP, FY'92 JOINT AUTHORIZATION HEARING

OPENING STATEMENT

GOOD MORNING LADIES AND GENTLEMEN. TODAY WE JOIN WITH THE ARMED SERVICES SUBCOMMITTEE ON R&D TO REVIEW THE STATUS OF THE NATIONAL AERO-SPACE PLANE PROGRAM. IT IS NOW SEVERAL YEARS INTO ITS TECHNOLOGY DEVELOPMENT AND DESIGN DEFINITION. IT IS CRITICAL THAT WE KEEP A TIGHT DISCIPLINE ON THIS PROGRAM SO THAT THE PHASE 3 DECISION TO BUILD THE X-30 IN 1993 PRESENTS NO UNADDRESSED OR UNRESOLVED PROBLEMS.

THE WELL OF HIGH PERFORMANCE AERONAUTICAL TECHNOLOGY HAS RUN DRY. AERONAUTICS TODAY IS LARGELY LIMITED TO AIRFRAMES AND ENGINES OF 1950'S VINTAGE TECHNOLOGY, MAYBE HI-FIED TO A DEGREE.

THE NATIONAL AERO-SPACE PLANE PROGRAM IS CONCEIVED TO CORRECT THIS 30 YEAR LAPSE

AS WELL AS TO BRING NEW AND MORE POWERFUL U.S. TECHNICAL MUSCLE TO OUR INDUSTRY, TO THE MILITARY, AND TO THE U.S. INTERNATIONAL COMPETITION ARENA. THE NASP DEMANDS A SIGNIFICANTLY HIGHER TECHNOLOGY LEVEL THAN, FOR EXAMPLE, THE SANGER OR HERMES CONCEPTS.

NASP OR X-30 TECHNOLOGY WILL SPAN THE ENTIRE AERONAUTICAL ENVELOPE THROUGH ALL REACHES OF THE EARTH'S ATMOSPHERE INTO SPACE: THE ATMOSPHERE THAT SUPPORTS OUR EARTHLY AIR TRANSPORT, THE ATMOSPHERE THAT WILL ALWAYS BE HERE, THE ATMOSPHERE THAT IS THE NEAR-NEMESIS OF THE SPACE PROGRAM.

THE SOLUTION IS TO RETURN TO BASIC AERODYNAMICS AND ENJOY ONE TO TWO ORDERS OF MAGNITUDE IMPROVEMENT IN EFFICIENCY OVER OUR CURRENT PRACTICE THAT IS LOCKED INTO ROCKETRY.

THE NASP PROGRAM IS FOR THE 21ST CENTURY:

1. IT REVITALIZES THE BEST ELEMENTS OF THE RESEARCH AIRPLANE PROGRAM THAT

SERVED US SO WELL AFTER WW-II ALL THE WAY TO DESERT STORM.

2. IT WILL PROVIDE TRUE EXPERIMENTAL DATA ALLOWING DERIVATIVES TO FLY FROM A RUNWAY ON EARTH TO ANY ORBIT, WITH FACILITY, FLEXIBILITY, AND ECONOMY. NO SUCH IMPROVEMENT IS ENVISIONED IN CURRENT SPACE PROGRAMS.

3. THE NASP INDUSTRY TEAMING CONCEPT PROVES WE CAN COMPETE AS A COUNTRY WITH THE WORLD RATHER THAN HAVING A SINGLE COMPANY COMPETE ON BEHALF OF AMERICA UNDER HISTORIC RULES THAT SEEM TO FAVOR OUR COMPETITION.

4. NASP TEAMS THE BEST AERONAUTICAL RESOURCES THAT NASA, THE DEPARTMENT OF DEFENSE, AND THE AEROSPACE INDUSTRY HAVE TO OFFER. THIS GIVES US THE MILITARY/GOVERNMENT/INDUSTRY COMPLEX AT ITS BEST. AND, BOTH DOD, NASA, AND INDUSTRY FORECAST TREMENDOUS LONG TERM DEPENDENCE UPON THIS INVESTMENT IN THE FUTURE.

THE ADMINISTRATION HAS RECOGNIZED THIS

PRESIDENTIAL INITIATIVE AS ONE OF THE KEYS TO FORESTALL OUR LAPSING INTO A SECOND CLASS REACTOR TO INTERNATIONAL INITIATIVES.

THE AGGRESSIVE INTEREST AND INVESTMENT IN THE NASP PROGRAM SHOWN BY THE U.S. AEROSPACE INDUSTRY IS UNPARALLELED AND DEMONSTRATES THE MOOD AND NEED FOR SUCH A VENTURE.

THE AGGRESSIVE INTEREST IN THE NASP PROGRAM SHOWN BY ALL OF THE INDUSTRIAL NATIONS OF THE WORLD, FROM JAPAN, TO ALL OF EUROPE AND THE USSR PROVES THE WISDOM OF OUR CHOICE OF HOW TO STAY IN AND WIN THE RACE IN U.S. STYLE. THEY ALL, UNDERSTANDABLY, WANT IN BADLY.

WE ASSEMBLE TODAY IN UNIQUE UNISON WITH OUR PARTNERS FROM THE ARMED SERVICES R&D SUBCOMMITTEE TO DEMONSTRATE THE NATIONAL CHARACTER OF THE NASP.

OPENING STATEMENT OF THE HONORABLE RONALD V. DELLUMS
RESEARCH AND DEVELOPMENT SUBCOMMITTEE CHAIRMAN
12 MARCH 1991

THANK YOU, CHAIRMAN VALENTINE. THE RESEARCH AND DEVELOPMENT SUBCOMMITTEE IS PLEASED TO CO-CHAIR THIS HEARING WITH THE TECHNOLOGY AND COMPETITIVENESS SUBCOMMITTEE, TO RECEIVE TESTIMONY ON THE NATIONAL AEROSPACE PLANE (NASP).

WE ARE AWARE THAT THIS PROGRAM HAS BECOME A POLITICAL ISSUE BETWEEN THE HOUSE AND SENATE IN FY 1991 AND BETWEEN CONGRESS AND ADMINISTRATION DURING THE FY 1990 DEFENSE BUDGET DEBATE. ONE BODY SUPPORTING AND ONE BODY DESIRING TO ELIMINATE THE PROGRAM. I THINK IT IS TIME TO TAKE THE POLITICS OUT OF THE PROJECT AND SERIOUSLY AND SENSIBLY ADDRESS WHAT THE CONTINUATION OF NASP MAY HOLD FOR THE U.S. IN THE LONG RUN AND DETERMINE WHAT SUPPORT EXISTS IN THE ADMINISTRATION TO ENSURE PROGRAM CONTINUITY IN THE OUT YEARS. THIS WILL ALLEVIATE MUCH OF THE APPREHENSION HELD BY INDUSTRY TO FULLY COMMIT ITS VALUABLE TALENT AND RESOURCES TO THE PROGRAM. THIS PROJECT PROMISES TO ENSURE U.S. AEROSPACE SUPREMACY BUT THAT WILL ONLY HAPPEN IF THE ADMINISTRATION IS WILLING TO MAKE A LONG TERM COMMITMENT AND PROVIDE THE SUPPORT NEEDED TO BRING THE NASP TO FRUITION.

NEITHER I NOR MEMBERS OF MY STAFF HAVE HEARD MUCH REGARDING PROGRESS IN THE PROGRAM LATELY TO HELP US GAGE OUR MEASURE OF SUPPORT FOR THE REQUEST, SO WE ARE ANXIOUS TO LEARN MORE THROUGH THIS HEARING. I AM ESPECIALLY INTERESTED IN HOW THE PROGRAM IS MANAGED AND REVIEWED BY THE DEPARTMENT OF DEFENSE AS WELL AS HOW THE NASA/AIR FORCE/INDUSTRY TEAMS FUNCTION. I EXPECT THAT A NUMBER OF LARGE SCIENCE PROJECTS WILL BE COMING UNDER FIRE AS BUDGETS TIGHTEN SO IT IS INCUMBENT FOR PROGRAM PARTICIPANTS TO EXHIBIT GOOD MANAGEMENT AND CAREFUL OVERSIGHT AS SOME MEANS OF CONTROLLING COSTS.

GENTLEMAN, THANK YOU FOR APPEARING HERE TODAY. I YIELD TO THE RANKING MINORITY MEMBER OF THE RESEARCH AND DEVELOPMENT SUBCOMMITTEE, MR. BOB DAVIS, FOR SUCH TIME AS HE MAY CONSUME.

STATEMENT OF D. ALLAN BROMLEY, ASSISTANT TO THE PRESIDENT FOR SCIENCE AND TECHNOLOGY, AND DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY POLICY

Dr. **Bromley**. Thank you, Mr. Chairman. Mr. Chairman, as Director of the Office of Science and Technology Policy, I'm delighted to have this opportunity to meet with you and the members of the committee to discuss the President's Program for the National Aerospace Plane.

It is our scientific and technological strength that over the years has provided us with the qualitative edge that has ensured our deterrent capability and helped us to preserve peace worldwide. And the impressive achievements of our coalition in the Gulf, I think bear testimony to the central importance of our ensuring our technological strength.

It's equally true today, more than ever before, that one of the key determinants of the strength of our economy is our proficiency in technology. And in the marketplace, the difference between success and failure frequently comes down to the question of who has the edge in technology. So I submit to you, gentlemen, that if we are going to remain an economic leader, then we need to nurture our advantage in a whole spectrum of critical technologies.

And at the direction of the Congress, my office is just now completing a detailed study of the critical technologies that will be of greatest importance to our Nation in the years ahead, both for economic competitiveness and for national security. And although that report will not be transmitted to the Congress for a matter of weeks, I think that it is not giving away any secrets if I confide to you that aeronautic technologies figure prominently in the list of critical technologies.

As has been mentioned already, aeronautics is one of the areas where we have traditionally had U.S. leadership demonstrated on a worldwide basis. And I think that it is vitally important that while our U.S. leadership still remains strong, it is in increasing jeopardy. Particularly, are we challenged in many of the technologies that underlie aeronautics. If we are to maintain our competitive advantage in commercial aviation, and maintain the vital superiority that we have just demonstrated in our military aircraft, it seems to me that it is essential that we retain our position on the cutting edge of aeronautic technology. And, in my view, the National Aerospace Plane, as has been noted before, is a sterling example of government-industry cooperation in advancing the generic technologies that promise a wide range of benefits, both in defense and in the commercial realms.

I have been very much impressed, for example, by the teaming concept that has been developed among the five prime contractors for the NASP activity. I have also been enormously impressed by the work that has gone on during this past year and, more, in the Phase II Program of NASP, particularly in terms of the successes that have been registered in the areas of material science, of aerodynamic science, and of propulsion technology. Those three areas are vitally important to our future. We have made major progress. And I believe all those involved deserve congratulations from all of us.

I have, as Director of the Office of Science and Technology Policy, been an honorary member of a NASP Steering Group that meets periodically to review progress of this program. We met last in November to review progress to date, to examine the exit criteria for Phase II, and to begin at least some discussion of Phase III of this very important program.

I think that I would emphasize that Phase III is a research program, but a research program of which the construction and testing of an experimental vehicle is an integral part. And from the very beginning of the NASP Program, as has been mentioned here today, one of the goals clearly has been that of developing airbreathing vehicles ultimately capable of single-stage-to-orbit performance.

I think, as I have already mentioned, one of the key arguments for the NASP Program has been that of maintaining our leadership in the aerospace industry. A second, and very important argument has been that of developing this single- stage-to-orbit craft which holds the promise of the marked reduction in cost-per-pound-to-orbit that is an essential part of making commercial space a realistic future prospect.

And so I think that we have made very excellent progress thus far. The Phase II exit criteria have been tailored specifically to assure that as we move forward to make the decision about Phase III, we have sufficient confidence in the technology that we have developed so that building the X-30 is a realistic, reasonable next step in our march toward accessible space. And the go-ahead in moving from Phase II to Phase III clearly depends on a demonstration of that technology.

Once the criteria that have been set forth by the Steering Group, by others, have been met, as has been noted by Mr. Lewis, I, myself, would be very strongly in favor of moving forward to Phase III. I believe that were we to limit ourselves to simply a generic hypersonics technology program after Phase II, that we would not in fact insure ourselves of the advantages in terms of leadership in the aerospace industry, in terms of moving toward access to space that would otherwise be ours. And I think that we would not maintain the leadership that I believe is within our grasp for an extended period.

The National Aerospace Plane, Mr. Chairman, I think represents the sort of extraordinary and visionary undertaking at which this country really excels. And it establishes a goal for us toward which we can together work for the benefit of whole sectors of our industrial economy. I want to commend the Congress, and in particular the members of the two committees represented here today, for continuing support for NASP.

And with that, Mr. Chairman, let me terminate my remarks and respond to questions that you may have.

[The prepared statement of Dr. Bromley follows:]

THE HONORABLE D. ALLAN BROMLEY
STATEMENT PREPARED FOR DELIVERY

COMMITTEE ON SCIENCE SPACE AND TECHNOLOGY
COMMITTEE ON ARMED SERVICES
U.S. HOUSE OF REPRESENTATIVES
MARCH 12, 1991

THE NATIONAL AEROSPACE PLANE

Chairman Dellums, Chairman Valentine, and Committee Members:

As Director of the Office of Science and Technology Policy, I appreciate the opportunity to appear before you to discuss the President's program for the National Aerospace Plane.

We could not provide for the security of the United States or our Allies were it not for America's tremendous scientific and technological strength. It is that strength which provides the qualitative edge that has long ensured our deterrent and helped preserve the peace. The impressive achievements of the coalition forces in the Gulf are testimony to the central importance of ensuring our technological superiority.

It is equally true that today, more than ever before, one of the key determinants of the strength of our economy is the proficiency of our technology. In the marketplace, the difference between success and failure often comes down to who has the better technology. If this country is going to remain an economic leader, we will need to nurture our advantage in critical technologies.

At the direction of Congress, my office is currently overseeing a government-private sector panel that is identifying and analyzing just which technologies will be of key importance to our Nation's security and economic health. The panel has nearly completed a report of its findings, which will be transmitted to the Congress. But I do not believe that I will be giving away any secrets if I confide in you that aeronautics technologies figure prominently in the panel's work.

As the Members of these Committees are well aware, aeronautics is a traditional area of U.S. preeminence. Our aircraft industry has led the world in military and civilian aircraft performance and production, as well as export sales. While U.S. leadership remains strong, it is under increasing challenge, particularly in many of the technologies underlying aeronautics. Advances in these technologies have the potential of revolutionizing aviation. If the United States is to maintain our competitive advantage in commercial aviation, and sustain our vital superiority in military aircraft, we must remain on the cutting edge of aeronautics technology development.

The National Aerospace Plane is a sterling example of government-industry cooperation in advancing generic technologies that promise broad application in both the defense and the commercial realms. And, in my view, many of these technologies will be of key importance to our Nation's competitive standing.

As you will recall, work on the NASP is being carried out by a unique teaming arrangement among the five prime contractors, who share proprietary information with one another working within a common team. The idea is to concentrate talent on the program and to emerge with all five companies competent in hypersonics at the end of the X-30 effort. I am very excited about the teaming arrangement, but I should note that this novel approach is not without its critics. Some have been concerned that the teaming arrangement would work as a disincentive to creativity because competition is removed. That is something we will all want to watch and evaluate carefully. But if the NASP teaming arrangement proves the critics wrong, it may serve as a very fruitful model for future endeavors.

The government-industry relationship is also unique in that government laboratories and research centers have responsiblity for explicit pieces of work on the program's main development path. This is a significant departure from the customary generic R&D role of government researchers.

As the Director of the White House Office of Science and Technology Policy, I serve as an honorary member of the NASP Steering Group, which provides national level oversight and guidance to the NASP Program. This group last met in November to review technical accomplishments to date and provide guidance for moving to the next stage -- Phase 3 -- of the NASP Program.

The objective throughout Phase 2 has been to develop the technology, design, and program plan to substantiate an X-30 research vehicle. I can report that overall progress under Phase 2 has been outstanding. Among the many technical accomplishments was the development and validation of tip-to-tail computational fluid dynamic codes for hypersonic forebody, inlet, and nozzle component flows. And in the area of advanced materials, the NASP program successfully manufactured titanium metal matrix composite panels to be used for thermal protection on the underside of the X-30.

I want to emphasize that the X-30 is a research (pre-milestone zero) program, of which Phase 3 -- the construction and flight testing of an experimental vehicle -- is an integral part. From the beginning, the goal of the NASP Program has been to demonstrate the technology required for airbreathing vehicles ultimately capable of single-stage-to-orbit (SSTO). But it has never been planned to demonstrate the technology required for SSTO operation in Phase 2. That challenge remains ahead of us. Rather, the Phase 2 exit criteria have been tailored specifically to assure that we have sufficient confidence in the progress of NASP technology development prior to building the X-30.

The go-ahead to build the flight test vehicle will depend on the technical evaluation that will take place at the conclusion of Phase 2. Much is therefore riding on the success of Phase 2. From everything I know of the program's maturity and progress, I would say that the national team should be in excellent shape to meet the Phase 2 exit criteria in FY 93.

Once those criteria are met, I would be strongly in favor of moving forward to Phase 3. In my opinion, limiting our efforts to a generic hypersonics technology program after Phase 2 would not ensure the U.S. a technological lead. I also believe a generic technology program alone would not provide the foundation for an experimental flight vehicle program, because the highly qualified contractor team would be disbanded and integrated vehicle design activities -- the heart of hypersonic flight -- would cease.

The National Aerospace Plane represents the sort of extraordinary and visionary undertaking at which this country excels when we put our minds and our national commitment behind it. I want to commend the Congress, and in particular the Members of your two Committees, for your continuing support for the President's NASP program.

Mr. VALENTINE. I think that since you have to leave us, Dr. Bromley, that we will, if the other gentlemen will abide with this, that we will undertake to ask you a few questions, and then go on with the other members of the panel. Will you — these questions—the reason I'm hesitating—are really directed at the entire panel, but I will ask the questions of Dr. Bromley, and you might not have this material here with you. And if not don't hesitate to say so, or you might want to send in a written answer to this question. It's not designed to try to catch anybody off guard.

I would like to ask you, Doctor, though, if you know of any issues in connection with our effort to move ahead with this program that we are not addressing in the Congress adequately. Is there any issue, in your opinion, which is yet to be resolved that could cause hesitancy or any problems with future decisions?

Dr. BROMLEY. Mr. Chairman, from my vantage point in my office I do not see specific issues, but I would defer to my colleagues in the Defense Department and in NASA who are closer to the detailed aspects of the program. They may well have insights toward answering this question that I lack.

Mr. VALENTINE. Last year in our report we asked DOPA/NASP government baseline concept be updated with current knowledge and a comparison of differences with the current configuration that had been given to us. Can you give us the status of that report?

Dr. BROMLEY. Again, Mr. Chairman, with your permission I would defer to my colleagues on that because they have much better information on it than I do.

Mr. VALENTINE. We'll come back to these questions, Doctor, when we have heard the testimony of the other witnesses.

And at this time I will recognize the ranking member of our subcommittee, Mr. Tom Lewis, from the state of Florida.

Mr. LEWIS. Thank you, Mr. Chairman. Dr. Bromley, your testimony expresses strong support for the NASP, but there's still questions being raised about the value of the program. And I would be interested in how you respond to critics who say that NASP is a big science program that takes funding from, say, small science programs. How do we respond to something like that?

Dr. BROMLEY. Mr. Lewis, this is a question that we get in all sorts of guises. And I think, first of all, I'd have to say that in any budget that we bring forward to you in any given year, we are maintaining a balance between the support of the individual investigators, scientists and engineers doing what they really want to do today and, on the other hand, we're investing in the facilities that will take these same investigators to the frontiers five and ten years downstream.

NASP is one of those investments that can, in a realistic sense, provide access to a very large number of our investigators to the unique characteristics available in space. And so, the line between large projects and small projects is drawn generally much too sharply. There's a very large gray area. And many of the people who are taking advantage, and will take advantage, of the so-called mega projects or large projects are in fact small scale investigators. Facility members with a few post-docs or students, or individual investigators from industrial laboratories.

So, frankly, I think the separation is far to easily drawn. There's a very large gray area. And in the end we are developing this balance between support of today's work and opening up tomorrow's frontiers.

Mr. LEWIS. I thank you for that, and I notice in your testimony on page three where you have some concern about a disincentive to creativity because of the consortium that has been formed and competition would be removed. And you feel very strongly that if NASP teaming arrangements prove critics wrong, it may serve to be a very fruitful model for future endeavors.

In your opinion, how do you think this approach—or do you feel that this approach is the best way to attack our foreign competitors who are looking at hypersonic flight? Though recognizing this is an experimental vehicle and much can be derived from it, how do you feel—do you feel this is the best way to combat foreign competition?

Dr. BROMLEY. I believe, Mr. Lewis, that this is a very important way. There's no question about that. It is not the only way, but it is a very important part of our overall national program of competitiveness. Because, frankly, in this Nation in sector after sector of our industrial activity, we have the know-how, the technology, the industrial strength, if we put it together into a critical mass, to take on any competition from anywhere on the planet. If we, however, remain isolated and fragmented, then we can be picked off piece by piece or we can be less than competitive.

And I believe that this is an example, sir, of a situation where by bringing together the strengths that the various commercial members of this teaming activity bring to the development of this particular project, that combination together has a sum which is much greater than the simple arithmetic total of the parts.

I also believe that this is an approach which can be used in a great many other areas where we can share, cooperate, develop technologies which we can then separate and compete with the best anywhere. But we will not have forced American participants to individually develop the technological wheel each time that wheel may be necessary when we know full well that our international competitors are working together, and with strong help from their respective governments, to do this in a cooperative fashion.

I do not believe, sir, that we can be competitive unless we develop this kind of cooperation. And I am pleased to see this is an example.

Mr. LEWIS. Thank you, Dr. Bromley, for that observation. And thank you, Mr. Chairman, thank you for attendance.

Mr. VALENTINE. Thank you, Mr. Lewis.

The Chair will at this time recognize Congressman Dave McCurdy, from the state of Oklahoma.

Mr. MCCURDY. Thank you, Mr. Chairman. Dr. Bromley, I have two basic concerns. One is I would agree with you that the teaming approach offers perhaps a model for future efforts in research and development in that it is a significant step, my concern is with the uncertainty beyond Phase II and the decision not to be reached on Phase III until fiscal year 1993. Is there sufficient incentive for this team to move forward and be motivated?

One of the problems we've had through this program, and I've been actively involved with it since the mid-1980s, has been the fact that there has not been an almost lead agency out there taking the charge and saying, "By golly, this is our number one priority, and we're going to complete it." And you've always had this debate in NASA, for it one year and DOD the next. And we get some more DOD funds in there, and the next year it's cut out. And that uncertainty is what bothers me the most about keeping this team together.

If we are to be competitive, if we are to take that advantage into the next century, if we are to make this program a reality, then I think what I'd like to hear more than just hearing the President's commitment, which should be enough, I'd like to hear your commitment as far as working with NASA and the Department of Defense to insure that their commitment is going to be there more than just words. That their funding is there and that they are going to support this in order that we can translate that into something meaningful for this contract team, which, by the way, has invested over $700 million as an industry.

Dr. **Bromley**. Well, let me say first of all, sir, that as an honorary member of this Steering Group, I must say that I was enormously impressed at this most recent meeting by the general sense of enthusiasm. Something I'd not seen before. And I think it reflects the real progress that everyone recognizes has been made during this past year. And I, of course, would defer to my colleagues for more detail on that. But as someone looking in a little bit from the outside, I felt that there was a rather remarkable sense of accomplishment of future opportunity. And so I think it augurs well for the cohesion of this group of teamed industries.

From the other side in terms of the kind of support that you are asking for, let me first of all say that I personally feel very strongly that this is a very important project. It is a Presidential Initiative. I see very major advantages to the U.S. And I can report to you as well that the Space Council, chaired by the Vice President, has met specifically to consider this question. And there is really no question either in the minds of the President or the Vice President that this is a project that they both wish to see succeed and to move forward.

And that I think, sir, is the best evidence I can give you for what I believe to be the future prospects of this particular project.

Mr. **McCurdy**. I think it's important, it's also relevant, that it took NASP's inclusion in a presidential speech in the mid-1980s with President Reagan to elevate it to a program. And I'm pleased that President Bush is also trying to keep a high profile on this position.

One of the reports that came out recently to this committee was the Augustine Report on Space. And, unfortunately, NASP within that report received, I think, a positive indorsement, but it was a rather lukewarm endorsement as far as a sense of urgency in the schedule. And what I am trying to emphasize here, and I think I'm trying to elicit from the panel, over time is which of two polar extremes are they going to be? If it's a top five priority of the Bush Administration, then it ought to receive priority funding and support. If on the other hand they're going to follow the Augustine line, well, we support it, but we'll leave placeholder amounts in the budget in the out years and we'll figure out what that amount of money is going to be.

We share your vision. As a matter of fact, I think this committee has probably forced you on the vision and supported and driven that vision to the edge of the envelope. But we also have to deal in realities. We'd like to see some budget numbers in there. We'd like to see some dollars so that there is a little more predictability that we know there is a long term commitment because that's what the servicers work on, that's what the contractors work on, and that's what we have to plan with.

D. BROMLEY. I would let my colleagues speak for themselves and their agencies on this. But from my vantage point, from my participation in the discussions that lead to the placeholder numbers you mentioned, those were not put in through any lack of interest in the future of the project, but rather simply because we are waiting to see the completion of the Phase II to get a better hold on what is a realistic number to put in those entries to replace the placeholders now there.

Mr. MCCURDY. And that decision is due when? Is there an actual date?

Dr. BROMLEY. I don't have an exact date for it, perhaps my colleagues do.

Mr. MCCURDY. The problem is we start the 1993 budget this time next year. It's interesting, last year's hearing was March the 13th, today's the 12th. We've had some regularity from this committee at least in our support for this program. But we start next year on the 1993 budget, we'll be discussing 1993, and if you're waiting to assign a number in 1993 for the 1990 fiscal year, you may be behind the curve. So that's what I'm trying to get a little more emphasis and support on.

And I thank the gentleman for his support and for your statement.

Mr. VALENTINE. Thank you, sir.

The Chair recognizes at this time the ranking member of our companion subcommittee, Research and Development of Armed Services, Congressman Bob Davis, from Michigan.

Mr. DAVIS. Thank you, Mr. Chairman. I think at this time I'll pass. I know Dr. Bromley's in a hurry, and I have some questions I can ask the other members. So I would be pleased to pass and save my questions for the other members.

Mr. VALENTINE. Thank you, sir. Let me say that the Chair's attempting to recognize members from the time that they come in here. We are maybe not succeeding as we should. Mr. Bennett I think has departed temporarily, and I think on the Republican side Congressman McCrery from Louisiana was next. Congressman Edwards from Texas? Congressman Kyl from Arizona? Mr. Rohrabacher from California? Questions?

Mr. ROHRABACHER. Dr. Bromley, at times it has seemed that we're trying to rush so headlong into space that we may be skipping the logical steps of what could make our efforts successful. And what seems to me is we've added a lot of costs onto achieving some of our space goals by not going one step at a time. And I was wondering if you could just give us a very brief assessment as to what new capabilities the National Aerospace Plane technology would provide in terms of our space effort.

Dr. BROMLEY. Well, first of all, sir, when we achieve the design goals of the NASP Program single-stage-to-orbit, the estimates that are available to me at the moment suggest that we will have reduced the cost-per-pound-to-orbit by somewhere between one and two orders of magnitude. And it seems to me that will remove one of the very major barriers to our utilization of space, either from a commercial point of view or as the opening phase of our explorations of the last great frontier. So that in itself is an absolutely major step I see toward opening up space to effective access by us.

Beyond that, the work that is being done on the development of new materials, the titanium matrices, for example, the work that is being done on being able to do computer modeling of entire airframes so that we can really begin to understand from a fundamental point of view the airflow, the dynamic characteristics of whole families of new shapes, configurations, really makes it possible for us to think in terms of a whole new class of vehicles that we could in the ultimate future use as our access to space.

So we're opening up a whole new frontier here for space as well as, at the same time, these same techniques are the ones that will maintain our leadership in the aerospace industry that's going to, I hope, play a continuing and very important role in our balance of trade worldwide.

Mr. ROHRABACHER. Would you foresee the National Aerospace Plane type vehicles, for example, supplying the space station and things such as this? When we look at the space station, we're calculating the cost of how much it's going to cost for one takeoff. Wouldn't the National Aerospace Plane type vehicle really make economically viable in the future things like the space station, which today we seem to have a lot of trouble with?

Dr. BROMLEY. I think, sir, that this comes back to the question of the cost-per-pound-to-orbit. And no matter what we are doing in space, if we can reduce that cost substantially, we will greatly increase our access and greatly increase the scope of our potential activity in space. So what you mention is clearly one example of that.

Mr. MCCURDY. Will the gentleman yield?

Mr. ROHRABACHER. Yes.

Mr. MCCURDY. The gentleman's done yeoman's work on this program, and I commend him, but I wanted to follow up on one point. Dr. Bromley, and I think Dr. Herzfeld as well, have said time and time again that this is an issue to enhance the competitiveness of the United States, both in the aerospace field, but in a number of other areas—materials, science and others. One of the concerns that I've had serving on both committees is that, as we say, we win the Noble Prizes and the Japanese win the marketshare. We invent things very well. I mean, we are superb at that. And at some point, not only your comments, but I'd like other witnesses to follow through somewhat on the issues of engineering for "producibility." Those kinds of issues so that we—not only someday you guys can pat each other on the back and say, "Look how great that was" but someone else has the airline or someone else has the aircraft out there flying. How do you bridge that gap, and is this being kind of built into the system as we go?

I thank the gentleman for letting me insert that.

Mr. VALENTINE. Mr. Gilchrest? The gentleman from Maryland, Mr. Gilchrest.

We have to take a brief recess to go vote. If the witnesses would just bear with us, we shall return shortly. Doctor Bromley, I realize you have to leave. We appreciate your testimony here today and will submit any additional questions in writing that the members may have.

Dr. BROMLEY. Thank you very much, Mr. Chairman, I regret that I do have to take off now. Thank you.

Mr. VALENTINE. The committees stand in recess.

[Recess.]

Mr. VALENTINE. We'll get started, ladies and gentlemen, please. The members of the subcommittees will be trickling back.

The next witness on this panel is Dr. Thompson. Dr. Thompson, we'll hear from you at this time.

STATEMENT OF JAMES R. THOMPSON, JR., DEPUTY ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. THOMPSON. Thank you very much, Mr. Chairman. What I'd like to do, with your permission, is to submit my testimony for the record and then summarize my remarks.

I'm certainly very pleased to join my distinguished colleagues, Allan Bromley, Jack Welch, and Charles Herzfeld here today before this committee in testifying for the NASP Program.

In my judgement, NASP is one of the most visionary, challenging and potentially high payoff programs in aviation and space research and technology that we've got in the world today. Scramjet propulsion, materials, computational technologies, stability and control, slush hydrogen—all of these technologies are being pushed beyond the current state of the art, and they all lead to hypersonic flight.

Our design goal is very simple. Single-stage-to-orbit. Certainly there is a lot of technology to be put in place and a lot of hard work to execute this program. I've personally been very close to the program now for some two years and have been extremely impressed with the progress that the combined teams have made to date.

I believe that NASP is a unique program. It provides this country unprecedented opportunity to advance technology in earth-to-orbit transportation. And the flagship of this technology is to fly the X-30 in this decade.

The national team is now in place, and it's evolving a single X-30 design. And it incorporates, in my judgement and in NASA's judgement, the best features from the pre-teaming concepts.

I think the technical progress across the board has been impressive; the large scale structural components that have been built. Certainly and very clearly, the propulsion technology remains the long tent pole in this program. But I believe that progress across the board is going to put us in good position to make the appropriate decisions, and I believe we will proceed from a technical standpoint in 1993.

I can very clearly state that NASA is very strongly committed to this program and has been since day one. Today, we provide about a third of the resources and two/thirds of the people. Almost 300 of our most talented engineers and scientists in our NASA centers participate in this program.

NASP is the kind of program I believe that NASA and the Nation should be doing. It's tough, it pushes technology, and it's going to help all of us ensure that America is going to remain number one in aerospace in the next century.

And with that, Mr. Chairman, I will pass to my other colleagues and standby for questions.

[The prepared statement of Dr. Thompson follows:]

NASA
National Aeronautics and
Space Administration

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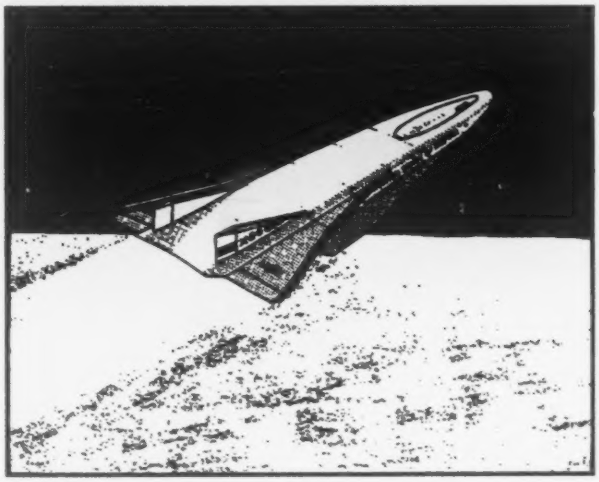
Presented by Witness

March 12, 1991

Subcommittee on Technology and Competitiveness Committee on Science, Space and Technology

Subcommittee on Research and Development Committee on Armed Services

House of Representatives



Statement by:

J.R. Thompson
Deputy Administrator
National Aeronautics and
Space Administration

102nd Congress

Mr. Chairmen and Members of the Subcommittees:

I am happy to again join my DOD colleagues in testimony on behalf of the National Aero-Space Plane (NASP) program.

NASP is the most visionary, challenging, and potentially high-payoff aerospace technology program in the world. Air-breathing propulsion, advanced materials and new structural concepts to go with them, and advanced computational methodologies to handle very highly-integrated propulsion/airframe systems, are all being pursued by NASP well beyond their current capabilities. NASP will enable entirely new classes of vehicles in the early 21st Century. Since the program is focused on critical single-stage-to-orbit technologies, space launch is an obvious application for a class of NASP-Derived Vehicles (NDV); however, there are clearly other NDV's which could provide dramatic increases in capability for reconnaissance, intercept, and many other missions. Since the potential applications for hypersonic technology are so diverse, other countries have initiated and/or expanded their related technology efforts. There is a strong desire in Europe for joint programs to develop air-breathing launch vehicles, and particular attention is being given by both the Europeans and the Japanese to the development of an infrastructure, including experimental facilities, which will enable such developments.

I have been very close to the NASP program over the past year and a half. I am very impressed with the program and the progress that has been made, and I am pleased with the competence of the national contractor/government team that has been assembled.

However, this important national program is in danger, as is our future international preeminence in aeronautics. The applications of NASP technology will not be available until the next century, and because of the enormous pressures on the Federal budget, NASP is vulnerable as a budget reduction candidate. The Administration is requesting necessary funding for FY 1992 and FY 1993, and I feel strongly that Congress must act to ensure stable and viable funding in these years to allow the maturation of NASP technologies to support the critical national decision in early 1993 on whether to build and fly experimental X-30 vehicles. NASP is a unique program, comprised of a unique and innovative government/industry team with high momentum working toward an unprecedented opportunity to advance aerospace technologies. Beginning in FY 1993 we are initiating a long term hypersonic technology program to continue to provide benefits to the U.S. well into the future. Availability of these technologies for the United States to build NDV's after the turn of the Century depends upon the NASP flight research program in this decade. In my remaining remarks, I will present NASA's FY 1992 Transatmospheric Research and Technology budget request and comment on both the programmatic and technical status.

The NASA FY 1992 budget request for NASP is $72M in Transatmospheric Research and Technology. This is fully consistent with the recommendation made by the National Space Council in its report on NASP in 1989. This request represents the NASA share of the required funding for X-30 design, propulsion system and airframe analysis and testing. As in prior years, NASA will augment its direct funding support to NASP by providing technical specialists, supercomputer capability and experimental test facilities at the Ames, Langley and Lewis Research Centers.

Last year I reported that the NASP contractors were committed to forming a national team whereby all five competitive firms could participate together with full cooperation toward a viable X-30 design. Today I am pleased to report that the NASP contractor national team has been successfully formed, and a National Program Office (NPO) has been established at Seal Beach, California. There has been a vigorous effort by the new team to define company roles and responsibilities in order to optimize the design and technology maturation process. It is important to note that the Program Director for the contractor team, selected from Rockwell International, has a Chief Engineer from General Dynamics and staff made up of key representatives from all of the participating companies. In total, the program has retained over 90 percent of the pre-teaming key personnel from the five companies involved.

There is an important effort in FY 1991, under the direction of the government Joint Program Office, to produce a new program plan for the remaining two and one-half years of the current technology development phase. This plan incorporates a process of Government Work Packages to enable the contract team to effectively utilize the crucial government expertise available to the program. These work packages provide for appropriate government involvement, and we are committed to make this new way of doing business work effectively. Further, the corporations behind the five NASP industrial partners are solidly committed to the success of the National Team.

This National Aero-Space Plane National Team, consisting of both the government and the newly formed contractor partnership, is currently evolving a single X-30 design which incorporates the best features from the pre-teaming competitive X-30 vehicle concepts. The flattened nose section produces lower drag at hypersonic speeds; it also blends well with the flattened lower surface, which controls and simplifies the flow into the modular engine array. Internally, the X-30 utilizes an effective combination of thermoplastic fuel tanks suspended within a metallic and carbon-carbon fuselage shell. The whole process of vehicle design is continually being fed by a rapidly paced stream of technology development that continues to yield crucial information.

Substantial progress has been made in propulsion technologies in the past year. Prior to teaming, an improved engine concept by Rocketdyne moved in a matter of months from conception through quarter-scale testing at speeds up to Mach 7 in facilities at NASA Langley. Performance predictions achieved excellent agreement with tests in the same facility for a one-sixth-scale engine concept developed by Pratt and Whitney. Tests of multiple engine inlets at NASA Lewis explored interaction between engine modules while single-inlet performance was evaluated in the Mach 10 to 14 range at the Naval Surface Weapons Center. Scramjet fuel-injector concept refinement continued through Mach 10 tests at the General Applied Science Laboratory and Mach 7 experiments at Johns Hopkins University/Applied Physics Laboratory. Mach 3.5 testing at NASA Lewis of a complete engine provided important insights into both performance and options for engine control systems.

Slush hydrogen, a mixture of solid and liquid hydrogen, leads to a smaller, lighter vehicle through added cooling capacity and increased fuel density. Efforts in the past year achieved an important milestone with the development and demonstration of flow-control techniques for large amounts (500 gallons) of slush hydrogen.

Key advancements also have included the fabrication of large-scale structures representative of elements of the X-30 vehicle. Tests continue on a McDonnell Douglas assembly of an eight-foot long, multi-lobe fuel tank of thermoplastics installed in a fuselage-shell segment made of a titanium metal matrix composite. Also, large panels of silicone-fiber-reinforced titanium from Textron have been assembled into a representative 4 x 8 x 8 foot NASP structure. General Dynamics and LTV completed an all carbon-carbon structure representing a 10 x 5 foot section of an X-30 wing.

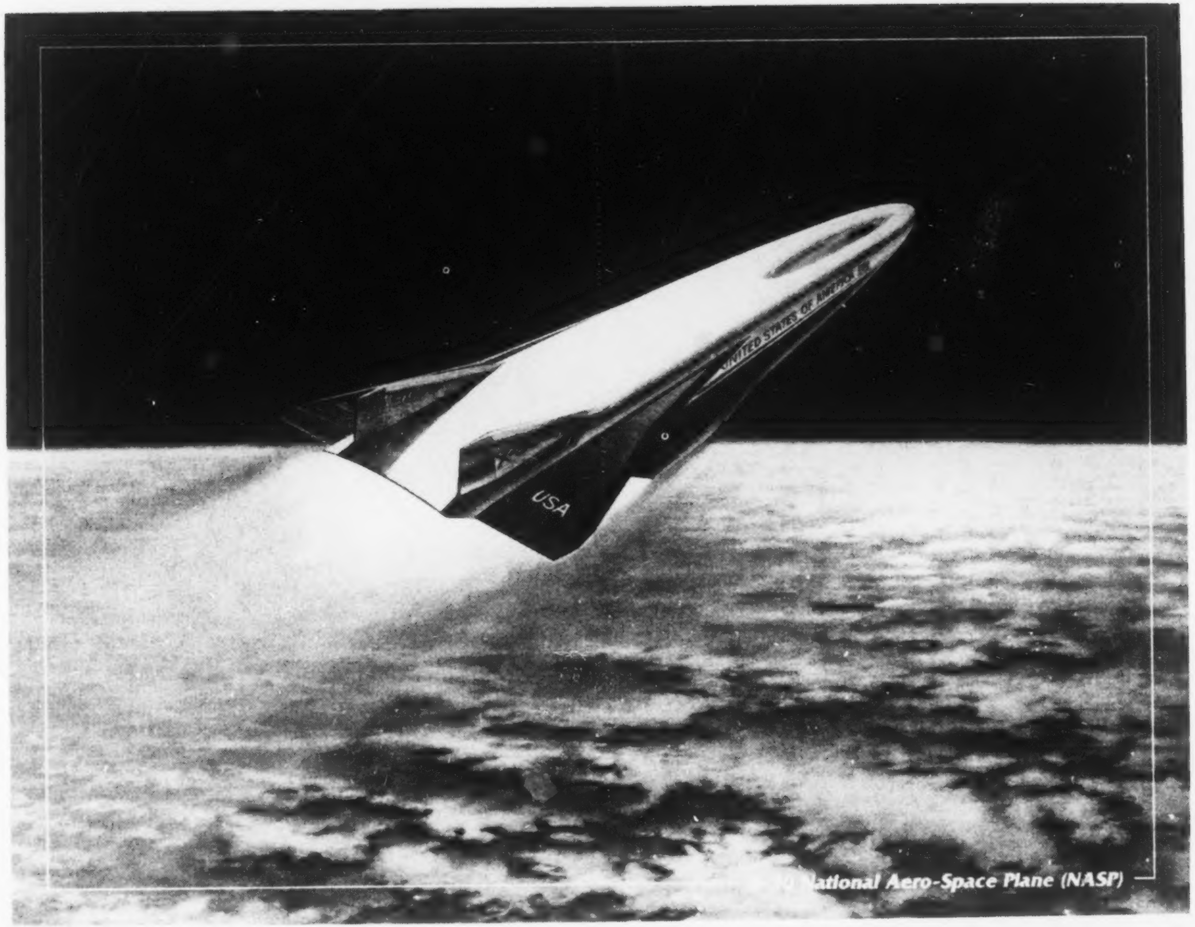
The localized extremes of X-30 heating require special systems and testing. Carbon-carbon panels with new silicone-carbide-based coatings have withstood over 200 cycles of NASP operational temperatures (running as high as 5000 degrees F.) Heat pipes, tested with high power lasers, have demonstrated the ability to endure the extreme heat loads produced by shock waves impinging the engine inlet lip at Mach 15. In addition, Rockwell International has successfully fabricated and tested their concept of a multi-layer insulation for fuel tank protection.

The aerodynamic data base continues to grow to meet the program's requirements. General Dynamics models have completed testing over the Mach 4 to 14 range, complementing data sets by McDonnell Douglas and Rockwell International. NASA researchers have provided valuable information on NASP related stability, control and the integration of aerodynamics and propulsion with a series of powered models covering the speed range from takeoff to Mach 20.

Computational fluid dynamics (CFD) has reached new milestones. A combination of computer programs can now calculate flow characteristics from nose to tail for an entire vehicle. Test data validations have increased the confidence in the NASP team's use of aerothermal computer codes, even to the point of using CFD to design details of the engine interior. Recent NASA Langley advances in boundary-layer transition prediction for hypersonic speeds have now been incorporated into contractor methods crucial to designs for surface heating and engine inflow.

Advances in flight systems, instrumentation and other areas continue to bring us closer to the final X-30 technologies. Flight tests at the NASA Dryden Flight Research Facility have explored the effects of limited visibility, since aerothermal loads prohibit front views out of large windows. New applications of laser-based methods are yielding data in the extreme environment of engine exhausts. Further, flexible simulations of the X-30 and its cockpit at NASA Ames/Dryden have enabled the evaluation of flight systems for both nominal and off-design flight conditions.

NASA remains very strongly committed to NASP. The NASA Research Centers continue to be a vital part of the dynamic national team for NASP technology development. We are pleased to work with the Department of Defense and the National contractor team toward the next major program milestone: the 1993 decision on whether to build and fly the X-30. We believe that the NASP epitomizes the type of advanced technology programs NASA and the Nation should be doing; pushing technology well beyond its current limits to help ensure continued U.S. aerospace preeminence.

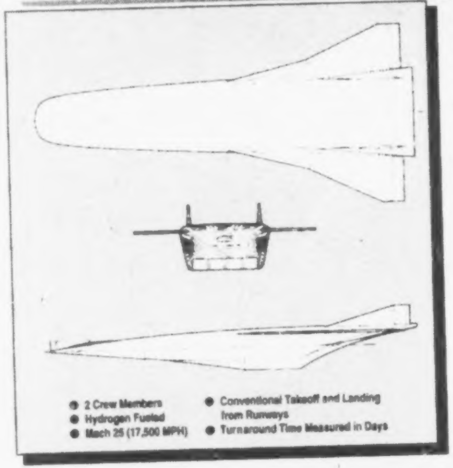


UNITED STATES OF AMERICA
USA

National Aero-Space Plane (NASP)

Made in America

Our Nation Cannot Afford the Alternative



- 2 Crew Members
- Hydrogen Fueled
- Mach 25 (17,500 MPH)
- Conventional Takeoff and Landing from Runways
- Turnaround Time Measured in Days

The National Team

DEPARTMENT OF DEFENSE

NASA

GOVERNMENT LABS
UNIVERSITIES
SUBCONTRACTORS
SUPPLIERS

GENERAL DYNAMICS
McDONNELL DOUGLAS
ROCKWELL INTERNATIONAL
PRATT & WHITNEY
ROCKETDYNE

The Flight of the NASP

The National Aero-Space Plane (X-30) is a national initiative managed by the Department of Defense and NASA. The objective is to develop hypersonic technologies and demonstrate airbreathing single-stage-to-orbit flight. With flights beginning in the late 1990s, the X-30 will launch this nation on a course that will maintain our aerospace lead in the world market of the 21st century.

X-30 — A New Era of Flight

The X-30 follows in the tradition of the experimental series of aircraft known as the X-planes, and will now permit us to enter a new era of hypersonics. The benefits derived from the early X-planes will pale in comparison to those military and commercial benefits that await us in the wake of the X-30.

Pioneer Management Approach

The X-30 national contractor team is a new approach for R&D management. After teaming was approved by DoD and NASA, the team members shared their technologies and X-30 configuration designs. The team used the beneficial approaches of each contractor to derive a new team X-30 configuration in October, 1990. This management concept may well be a model for cost-effective technology development in the future.

X-30 — Innovation for the Future

To fly the X-30, new materials, new propulsion approaches, and new analytical tools are under development. The advanced high-strength, high temperature, lightweight materials generated for the X-30 will benefit current and future military and commercial products — not only in aerospace but in numerous other fields as well. Future vehicles which emanate from the X-30 flight test program will generate new space transportation systems that provide low-cost, ready access to orbit; hypersonic transportation systems for endoatmospheric operations; and a new generation of military vehicles. Offspring of the X-30 may well dominate the skies of the 21st century.

The NASP Must Fly — And the Time is Now

The race is on with our international neighbors: Japan, England, Germany, France and the Soviet Union. If our nation is to maintain its significant positive balance of trade in aerospace–if this nation is to maintain its lead in aerospace in the new world market ... and we cannot afford the alternative ... we must maintain the momentum established on the X-30 program.

NASP

Mr. VALENTINE. Thank you, Dr. Thompson.
Dr. Herzfeld?

STATEMENT OF HON. CHARLES M. HERZFELD, DIRECTOR, RESEARCH AND ENGINEERING, DEPARTMENT OF DEFENSE

Dr. HERZFELD. It's a pleasure, Mr. Chairman, to be here and to participate in this very important hearing. I also would like to offer my prepared statement for the record and make a few summary comments.

As you know, DOD has supported the NASP program since it's inception, and we continue to support it in our Fiscal Year 1992 and 1993 request. With the National Aeronautics and Space Administration, we plan to complete Phase II, the technology and development phase, in Fiscal Year 1993. We'll make a decision regarding Phase III, the experimental flight vehicle phase, at that time. If our Fiscal Year 1992 and 1993 request is supported, the Department will have invested over $1.3 billion in the NASP Program. That's a large sum, even for the Defense Department.

The program content and schedule are in complete accord with the National Space Council recommendations that President Bush approved in July of 1989.

There are three important reasons for DOD participation. First, if the NASP Program achieves it's goals, the potential military benefits could be important. Vehicles derived from a successful NASP Program could provide much needed, rapid, cost-effective, flexible and reliable access to space, as well as extended hypersonic atmospheric cruise capability for several candidate military missions.

Second, the program is making good progress. The development and selection of airframe materials is proceeding very well. I would like to say parenthetically that the development of the new materials in the program is perhaps the most exciting, long-range evolution that will have, in all likelihood, very important commercial significance as time goes on.

We've obtained substantial amounts of data on engine component performance, and this has provided the basis for a more realistic assessment of overall engine performance. The program has demonstrated flow control techniques for slush hydrogen, which is also important.

The third reason is that the NASP technology effort will yield technology that's valuable in other areas of defense, including aircraft and missiles. The NASP Program's output of advanced lightweight, high temperature materials will be very useful to apply to aircraft and missile structures, to aircraft engines, and to space structures. The developments in computational fluid dynamics will also be critically important.

The DOD devotes considerable high-level attention to reviewing the achievements and direction of the NASP program through the NASP Steering Group, chaired by the Under Secretary of Defense for Acquisition. The Deputy Administrator of NASA, Dr. Thompson, is the Vice-Chairman, Dr. Bromley is a member; as are the Assistant Secretaries of the Air Force and Navy. The group reviewed the program last November and concluded that the program is on the right track. We also agreed on the exit criteria for Phase II—the specific accomplishments necessary before proceeding to Phase III.

We are committed to participating with NASA in the experimental flight vehicle phase of the program, after we obtain positive results from Phase II. We will be able to evaluate the nature and feasibility of an experimental flight vehicle program thoroughly during Fiscal Year 1993.

In summary, the DOD remains strongly committed to the NASP Program which I plan to emphasize in any further questions and answers later on, Mr. Chairman.

[The prepared statement of Dr. Herzfeld follows:]

HOLD UNTIL RELEASED
BY THE COMMITTEE

DEPARTMENT OF DEFENSE
STATEMENT BY
DR. CHARLES M. HERZFELD
DIRECTOR DEFENSE RESEARCH AND ENGINEERING
ON
THE NATIONAL AERO-SPACE PLANE PROGRAM
TO THE
SUBCOMMITTEE ON RESEARCH AND DEVELOPMENT
OF THE
COMMITTEE ON ARMED SERVICES
AND THE
SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS
OF THE
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES

MARCH 12, 1991

It is a pleasure to offer my views on the Administration's commitment to pursue the goals of the National Aero-Space Plane (NASP) program, since it is an important program to the Department and the Nation. In my view, there is no doubt about this commitment.

As you know, DoD has supported the NASP program since its inception, and we continue to support it in our Fiscal Year 1992 and 1993 request. With the National Aeronautics and Space Administration, we plan to complete Phase II, the technology development phase, in Fiscal Year 1993, and to make a decision regarding Phase III, the experimental flight vehicle phase, at that time. If our Fiscal Year 1992 and 1993 request is supported, the Department will have invested over $1.3 billion in the NASP program by this time. The program content and schedule are in complete accord with the National Space Council's recommendations approved by President Bush in July, 1989.

There are three important reasons for continued DoD support of the program. First, if the NASP program achieves its goals, the potential military benefits could be important. Vehicles derived from a successful NASP program could provide much needed rapid, cost-effective, flexible, and reliable access to space; they could also provide extended hypersonic atmospheric cruise capability for several candidate military missions. This is not only my personal view, but the view of the Joint Chiefs of Staff as well. I should also note that the NASP program is strongly supported by the Strategic Air Command and the Air Force Space Command, again because of the potential military benefits which a successful NASP program would offer.

The second reason for continued DoD support of the program is that good progress continues to be made. The development and selection of airframe materials is proceeding very well. A substantial amount of data on engine component performance has been obtained in the last two years, and has provided the basis for a more realistic assessment of engine performance than any made previously. And we have recently demonstrated flow control techniques for slush hydrogen. With the recent formation of the contractor team, we expect the rate of progress to increase.

The third reason for continued DoD support of the NASP program is that the current technology development efforts will yield technology which is valuable in other areas of defense such as aircraft and missiles. We anticipate that the efforts being conducted in the NASP program on advanced lightweight, high temperature materials will be very useful in applying these materials to aircraft and missile structures, aircraft turbine engines, and space structures. The developments in computational fluid dynamics will be applicable to many aeronautical systems. Similarly, the efforts on high-speed propulsion will be applicable to a wide variety of missiles.

DoD devotes considerable high-level attention to reviewing the progress and direction of the NASP program through the NASP Steering Group, chaired by the Under Secretary of Defense for Acquisition, with the Deputy Administrator of NASA as the Vice-Chairman. This Group reviewed the NASP program last November, and concluded that the program was on the right track. And agreement was reached on the conceptual exit criteria for Phase II -- those specific accomplishments which are necessary for consideration to proceed to Phase III. The Group did believe, however, that these exit criteria should be made more quantitative in order to minimize any future misunderstandings regarding what is expected from Phase II. This quantification is in process. We shall continue to monitor NASP progress closely.

As I am sure all of you are aware, DoD has programmed about $100 million per year for the conduct of Phase III. We are committed to participating with NASA in the experimental flight vehicle phase on the program, after positive results are obtained from Phase II. We will be able to make a thorough evaluation of the feasibility of an experimental flight vehicle program during Fiscal Year 1993.

In summary, DoD remains strongly committed to the NASP program.

Mr. VALENTINE. Thank you, Doctor.

Mr. Welch?

STATEMENT OF HON. JOHN J. WELCH, JR., ASSISTANT SECRETARY FOR ACQUISITION, DEPARTMENT OF THE AIR FORCE

Mr. WELCH. Mr. Valentine, Mr. Lewis, members of the committee, I do appreciate the opportunity to appear again before this committee to discuss the National Aerospace Plane.

It seems that each year it's expected that I say that the Air Force supports the National Aerospace Plane, and I'm here to say that again. And I really believe that we have shown over the past year, by the investment of very critical resources—not only money, but key people, facilities—and with the support of all of the people who have spoken to you here today, have in fact made great accomplishments.

Thompson and I look forward quarterly to being able to support the Review Meetings. And I can assure you that there's a pretty good lively discussion, and we are focused on those things that will in fact get us to an X-vehicle type research aircraft in 1993, on time.

I know there was a previous question that was asked with respect to unknowns. Certainly there are unknowns in these programs, and will continue to be. But to the best of our knowledge we have those, as we find them, on the list and they are specifically addressed.

As you know, NASP is a multi-agency research program, and I can never say in my experience have I seen a multi-agency contribution's to be more in a positive kind of a fashion. We even have a unique concept here where in fact the teams contract back. That's a complete integration with some of the government laboratories. The most positive approach to a demanding science and technology program I think perhaps the United States has seen.

The X-30 is a key characteristic. It will takeoff and land on a conventional runway and it will demonstrate single- stage-to-orbit. We believe the NASP Research Program will provide technology options for the next generation of operational aerospace vehicles.

The contractor team that was formed last May is working very well. We're very pleased with it. The details of the program will be described a little bit later by Barry Waldman and by Dr. Barthelemy, who are much deeper into the program certainly on a day-to-day basis than we are.

I think a very interesting aspect last year is how quickly were the formation of the teams. That each brought something to it, they were synergistically combined, and the new X-30 configuration is just a top-level example of all the gains that we've had by this type of management concept.

I know there's been some concern with the competitiveness and competitors for the future. I think there has been a sound address to international competitiveness. And I believe through the industrial team and the government consortium, there will be multi-competitors for programs like this in the future.

The technologies will be broken out. And I certainly don't need to remind this committee that this is an X-vehicle program. This is a pre-milestone zero, as we would talk about, it is going to lay in the foundations. It's been talked about as a flying wind tunnel, the foundations from which we can build upon and validate theoretical work that has been done.

In addition, this year the groups are working together to identify facilities for the out years. Facilities for hypersonic research, upgrades to some of the facilities that we have right now, and responding to some of the previous reports that have been done so that there is in fact continuity from the X-program that will fly to a program that lays a broad foundation for the future.

I will tell you that Air Force interest in hypersonics is higher than ever. I believe the committee has seen some of the various papers that have been written by our Major Command commanders, the Space Command, SAC, in terms of some of the concepts that they look forward to having a military capability as represented by some of the things that will be discovered, and in fact proven, through the X-vehicle program.

With that as a summary, I would certainly look forward to your questions. Mr. Chairman.

[The prepared statement of Mr. Welch follows:]

OPENING REMARKS

BY

THE HONORABLE JOHN J. WELCH, JR.

ASSISTANT SECRETARY OF THE AIR FORCE (ACQUISITION)

STATEMENT BEFORE THE

SUBCOMMITTEE ON RESEARCH AND DEVELOPMENT

COMMITTEE ON ARMED SERVICES

AND THE

SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

MARCH 12, 1991

Mr. Chairman and members of the Subcommittees, I appreciate the opportunity to appear today along with my colleagues from the Office of Science and Technology Policy, NASA, and the Department of Defense, for the fifth annual hearing to discuss the progress and plans for the joint DoD/NASA National Aero-Space Plane (NASP) program. NASP is an important program to the Air Force and the Nation. We look forward to your continued support this year in ensuring that the program is fully funded at the levels requested by each agency.

NASP is a national, multi-agency research program to develop the technologies for reusable airbreathing hypersonic vehicles. Key technologies include airbreathing propulsion, advanced materials and structures, actively-cooled structures and computational fluid dynamics. We plan to validate the technologies in the late 1990s with the flight of the X-30 experimental aircraft. The X-30 will takeoff and land on a conventional runway and, after atmospheric flight test, will demonstrate single-stage-to-orbit capability. The NASP research program will provide technology options for the next generation of operational aerospace vehicles.

While NASP continues to be one of our most challenging science and technology programs, I am pleased to report that significant programmatic and technical progress has been made in the last year. The five competing contractors are now working together as a team. This national contractor team continues to advance the state of the art in hypersonic vehicle design, hypersonic propulsion technology development, high temperature capable, lightweight structures and materials technologies, cryogenic slush hydrogen fuel manufacture and handling, and computational fluid dynamics.

The contractor team, which was formed last May, is working very well together, and is also working very well with its government counterparts. Because of this, we are already beginning to realize the benefits of contractor teaming. These benefits include technology spinoffs. Some examples are new advanced computational analysis tools, prosthetic joint replacements using titanium metal matrix composites, and thermal barrier material now being used by the home building industry.

Ideas and concepts also are being synergistically combined. The new X-30 configuration is an example. The competitive phase was completed with six potential X-30 configuration concepts; from these, the best technology and design features of each were identified, and then, guidelines for a new integrated configuration concept which takes advantage of these strengths were defined. This will result in increased technical depth and data at the 1993 Phase 3 X-30 build and fly decision point, and also make more effective use of funding and government and contractor technical resources.

Moreover, a competitive base for future hypersonic programs using NASP-developed technologies is being established. The five NASP contractors are sharing technology developments and each will be in a position to compete for future hypersonic systems. Finally, the NASP program will help ensure that the U.S. continues as the world aerospace leader in the 21st century.

Before I talk about our NASP FY 1992 plans, let me emphasize that we are making significant technical progress. The first design cycle for the new teamed configuration is complete and refinements to the engine, materials, structure, fuel, and subsystems are underway. Mr. Thompson's statement gives several additional examples of program technical progress.

Our FY92 activities build on FY91 tasks and events which include the first and second design cycles of the new X-30 configuration, four foot by eight foot cyrogenic tank and fuselage structural article tests, the first series of module-to module tests to determine potential interference effects between the engines, tests to validate external burning as an aerodynamic drag reduction technique, the decision on the use of slush hydrogen as the X-30 fuel, and design of the full-scale ramjet/scramjet concept demonstration engine which will be tested up to Mach 8. FY92 milestones include small structural article tests, structural test component fabrication including a large cryogenic tank, wing/ fuselage structural joint and one-quarter scale fuselage section for the new configuration, the initial Phase 3 cost estimate completion, fabrication and initial test of the concept demonstration engine, and the third and fourth X-30 design cycles.

The results of these milestones and other tests and analyses will help ensure we successfully meet the Phase 2 exit criteria. All evidence indicates that the remaining technological challenges will be met prior to the FY 1993 Phase 3 decision. In fact, we have started the environmental impact statement process to examine the infrastructure necessary to support X-30 flight tests at Edwards AFB/NASA Dryden Flight Research Facility. We are exploring new hypersonic facility construction and upgrades, and, in January, started an Air Force Scientific Advisory Board examination of the hypersonic technologies necessary to support operational airbreathing hypersonic military vehicles. The NASP research program is the point of departure for this study.

Air Force interest in hypersonics is higher than ever. The NASP program is our flagship science and technology program. I totally agree with the Strategic Air Command and Air Force Space Command assessment that NASP "represents a significant technology effort of enormous potential to the country and the military." Because of its importance, Mr. Thompson and I regularly review the the program and continue to be impressed by its progress. We are well on our way to a positive Phase 3 decision in 1993. With your continuing support and that of the government and industry NASP team, I believe this important national program will succeed.

Mr. **Valentine**. Thank you, Mr. Welch. Mr. Welch, can you describe for us the status of the contracts or contract, the program, we've just gotten into that phase of it, as I understand it, haven't we?

Mr. **Welch**. You mean working with the industrial consortium?

Mr. **Valentine**. Yes.

Mr. **Welch**. We believe that we have a very effective working relationship. Although a consortium, it is from a contractual standpoint a joint venture—which is an opportunity to directly contract, and we know how to do that.

We would address ourselves, too, to things like, say, earlier Safe Harbor legislation and some other acts that have passed that allowed us to go through the rather long— certainly from the committee's standpoint, I assure you from our's, too —rather torturous process to make sure we have not impinged upon competitors or competitiveness, that we have gone about meeting the acquisition rules of the country to have consortiums like this.

I believe that we are in fact in place. If your question is directed to when will we be approaching Phase III, as you know, it's in the second quarter of fiscal year 1993. And, again, we would expect that we would be contracting with the existing consortium.

Mr. **Valentine**. But is the program now under contract? Have contracts been let with industry to commence?

Mr. **Welch**. Yes, sir. I wasn't aware that there was a problem there. I think we're proceeding on the course. It has been several months now, I believe, since we had a milestone that we haven't met. It was met in January.

Mr. **Valentine**. Right, but the program up until recently, as I understand it, was not under contract. That is no agreements had been entered into with manufacturing companies to complete certain portions, certain phases. Now we understand that that is not the case now, and that the project is now under contract. What we would like to know is as of when was the contract signed, approximately? And if you can't tell us that off the top of your head, if you would supply that information.

Mr. **Welch**. January, 1991.

Mr. **Valentine**. And the length of the contractual obligations?

Mr. **Welch**. That will contract effectively through the decision process, which will be made in the second quarter of fiscal year 1993, with the intent to proceed with the next research vehicle in the fourth quarter of fiscal year 1993.

Mr. **Valentine**. Can you look into your crystal ball, Mr. Welch, and tell us what you think the show-stoppers are ahead of us? What are the problems; what are the pitfalls?

Mr. **Welch**. I tried to say in the opening statement, I think that in a vehicle like this, the single most important challenge will always be the propulsion system, including the slush hydrogen that's been discussed before.

I think we have material challenges, but I have to tell you so far we have been able to anticipate the areas that we would have difficulties. Some of the solutions that we started with, these can be discussed in some detail before, have not proven out as effectively as we would have hoped at the same time that we had parallel paths, and we have in fact found additional ways to proceed on that. And I'm sure that Dr. Barthelemy or Barry Waldman would be happy to talk in detail to that. But we do not believe that we have, either, any single path failure mechanisms identified.

Now, I think that Dr. Thompson could help me here a little bit on slush hydrogen. I think that's a very significant element that has to contribute and be handled with high mass flow for this to be successful. We are making that progress with sizeable use of slush hydrogen and intend to have a very high focus on that. But I could not comment on any that I know of.

Mr. VALENTINE. Dr. Thompson, would you like to add to that?

Dr. THOMPSON. Well, I think that I would just reinforce what Jack said relative to propulsion being the driving technology. And I anticipate by the 1993 time frame that we're going to have made sufficient progress and have sufficient data here technically to be able to proceed and not see a show-stopper. But I would also hasten to add that we're going to have to fly this plane before we really know that the technology works relative to the propulsion, the integrative propulsion, all the way from the airframe to the materials to the, as Jack indicated, the slush hydrogen that I think is going to come later in the program itself. I think the propulsion technology is going to drive the pace of the progress, and right now it looks quite good.

Mr. VALENTINE. You know, we're dealing with three very precious and fragile commodities—time, and money, and national and/or Congressional enthusiasm, that nebulous thing that seems to have changed over the past several months, even. In view of these situations, do you gentlemen think that it would be fruitful to make a concerted effort to accelerate this program, to move ahead with more speed than is presently understood to be the course of action? Dr. Thompson?

Dr. THOMPSON. Let me just add, I think the most important thing for the program today is the stability of funding. Here for the last several years, and we need for the next several, something in excess of a quarter of a billion. I think that's the number one priority for this program. We've been off again and on again as we go through the committee and the Congressional process. I believe that the agencies are committed. There's a lot of work to be done in this technology. I think if we can stay the course that we're on today, and stay the schedule, and get the stability of the funding, that's the right thing to do.

If the question is directed, but can't you accelerate it a year or so? I personally believe that that's probably too ambitious. I don't want to sound wimpish about it, but I just believe so much in the stability of the funding. It is rather ambitious that we've got—I think in light of an awful lot of other priorities that the Congress has, if we can sustain what we've put into effect and what the President's requested, then I think we're going to be in good shape technically and I hope we've got the national will to move forward with Phase III.

Mr. VALENTINE. Dr. Herzfeld, I would invite you to give your answer to these other questions, if you have anything you'd like to add, and I would also like to ask you if you would discuss with us briefly—give us the benefit of your judgement as to what you believe to be the military prospects for this program.

Dr. **Herzfeld**. Yes, Mr. Chairman, let me start with the last question, if I may, and add my comments to those of my two colleagues. Broadly speaking, I agree with them.

I think in order to really evaluate the importance of your question, one has to realize that we are dealing with several simultaneous technical revolutions. One is the power plant, which is unique, has never been done before, and has radical consequences if we can make it work. And all the evidence suggests that we can.

The second is the materials that we plan to use. There's a revolution in materials and structures at hand. The challenge is to make them economically and in large quantities. There isn't any question any more whether we can make them at all, we know we can.

And, finally, the fuel and heat management which, again, are really like nothing we've ever seen before.

Taking all these together, I would say I don't see any show-stoppers. There might be some, but they're not visible.

I also agree with Dr. Thompson that to speed up the schedule would be risky, and I think we would not gain as much as we would risk.

So, my comments on the first question are in fundamental agreement with my colleagues.

On the question that you raised next regarding the utility of the vehicle, from a defense point of view, there are several potential applications, obviously. The ability to launch directly into space from what would amount to a normal or nearly normal airfield, which is the ultimate objective of the program, is of tremendous importance. We've wanted to be able to do that for a very long time and have seen no other way to achieve it. If we can do it, the Defense Department will breath much more easily, I believe, in terms of the robustness of our access to space.

Second, if we get a true hypersonic flight capability out of this, as I expect we will, the ability to quickly launch a vehicle that could observe different areas of the world and get there very quickly, that could target areas of the world very quickly but not have all the complications of an intercontinental ballistic missile—it is an airplane still—has very many potential advantages.

There are studies going on now to nail this down more carefully, but we've already had sufficient expressions of interest from the military to be aware of these potential applications.

Mr. **Valentine**. In a lay language, we're talking about what kind of speed as compared to the maximum speed that has been achieved by a vehicle driven or steered by a human being?

Dr. **Herzfeld**. To the full single-stage-to-orbit you need about 10 times the speed of the Concord. That's pretty fast.

Mr. **Valentine**. But it is how fast?

Dr. **Herzfeld**. It's 24 times the speed of sound, whatever that comes out to in miles per hour. If someone will tell me, I will tell you. It's a calculation that's easy to do.

Mr. **Valentine**. So what one of the miracles that you're talking about is to develop a flying machine that will run how many times the speed of sound? Twenty-five?

Dr. **Herzfeld**. Twenty-four times the speed of sound. I believe that there will be early applications of considerable interest with significantly less speed than that. Perhaps five or ten times the speed of sound. And I foresee these perhaps as way stations to the ultimate objective.

Mr. **VALENTINE**. You understand, of course, that Mr. Scott Crossfield is available to fly that thing.

Dr. **HERZFELD**. Yes.

Mr. **VALENTINE**. Well, I have just a couple of questions, and I'll yield to my distinguished colleague from Florida. Dr. Herzfeld, I would ask you, please, if you would give us for the record the amount of money that has been requested by the Department of Defense for NASP?

Dr. **HERZFELD**. I'd be happy to do so, Mr. Chairman.

[The information to be provided follows:]

For the National Aerospace Plane program, the Department Defense has requested $231.8 million for Fiscal Year 1992 and $183.3 million for Fiscal Year 1993.

Mr. **VALENTINE**. And, Mr. Thompson, if you would give us for the record—Dr. Thompson, excuse me—the amount which has been requested by NASA for that part of it.

Dr. **THOMPSON**. Be pleased to do that.

[The information to be provided follows:]

The NASA request for FY 1992 with respect to the National Aerospace Plane (NASP) program is $72 million.

Mr. **VALENTINE**. And I will yield to the ranking member of our subcommittee, the gentleman from Florida, Mr. Lewis.

Mr. **LEWIS**. Thank you, Mr. Chairman. Dr. Thompson, in Public Law 101-611 that we passed last November, enacted last November, it basically established in law the requirement for a NASP aircraft and a demonstration by 1997. And it also required a management plan by the Secretary of Defense and the Administrator of NASA, which is due Saturday. Can you tell me what the status of that overall management plan is?

Dr. **THOMPSON**. I believe that that plan is now complete. I personally have not seen it; I think it's in the review process. And we're probably not going to make Saturday, but I think several weeks thereafter we'll get it over to this committee.

Mr. **LEWIS**. Okay. Certainly this plan will contain the overall goals and major task, as usual, and as the chairman was concerned about, the anticipated schedule as you can see.

What I have a concern about is that we slipped the program a couple years, and this was done mainly because of not so much because of technical problems, but because of financial and budgetary problems. Do you see from your viewpoint any technical problems that could stretch the program out another two to two-and-a-half years? I realize this is sort of a loaded question.

Dr. **THOMPSON**. I think from everything that we've seen to date, and the progress that we've made, no, I don't think I see any technical problems today that would hold up the progress of moving forward now into Phase III in the 1993 timeframe.

It is going to take some money to press on. I think it's going to be one of the best investments the country can make. If for whatever reason I don't foresee now the technical progress requires that we take another year or two, I believe that NASA and the Department of Defense will recommend that. But right now, I think that we'd like to stay on as fast a track as we can consistent with the technical progress. And that's the 1993 schedule.

Mr. **Lewis**. Dr. Herzfeld, on page three on your testimony, you say "DOD has programmed about $100 million per year for the conduct of Phase III." Is $100 million per year sufficient for this X-30 from you all's viewpoint?

Dr. **Herzfeld**. Mr. Lewis, we really don't know at this stage. And by agreement among the management team in all the organizations involved, each organization put a placeholder into it's long-term budget. I believe we will not have really good answers to this question until we are closer to defining what Phase III really is. And we can't do that until we are closer to completing Phase II.

It is important to realize what an enormous revolutionary step we're taking here, and that we are clearly in uncharted waters. We are trying to be careful and responsible with the use of public funds, and at the same time go as rapidly as we reasonably can. And so what you see is the best compromise that we were able to come up with. I don't know if my colleagues agree with my comment here, but I think it is important that we are all together on this.

Dr. **Thompson**. I would just like to add to that here, I think we've probably got another year of good, hard looking before we get a good feel for the cost. I think we'd rather have a better number than one that is too much of a guess. But I would answer your question just so we can start thinking and planning. One hundred million dollars a year from NASA and DOD is not going to put this airplane in the air during this decade; it's going to take more than that. I think what that number is is what we need another year to work on. But it is not at the technology level. I think we would be misleading and kidding ourselves if—I just think we're going to have to plan for more than that.

Mr. **Lewis**. I like that candid statement, Dr. Thompson. Mr. Herzfeld, you also said on page one of your testimony that you were "pleased to offer your views on the Administration's strong commitment to pursue the goals of the NASA Program." Is this sort of a change of heart? You know, the DOD was the very wobbles, as the phrase goes, two years ago.

Dr. **Herzfeld**. Well, Mr. Lewis, I just joined the Defense Department and the Administration a year ago, so I really can't speak first hand about how it was two years ago. But I can speak to the commitment that we have now.

Mr. **Lewis**. Okay. I would like to ask just one other broad question for the three of you. What do you feel is the position of the United States at this point in time with the X-30 development, the NASP development, through going through Phase II? And how do we compare with our foreign competition — Japan, United Kingdom, Sanger Program in Germany? You want to make any observations as to how they stack up against us at this point?

Dr. **Thompson**. Well, I think I would add, in a summary level, it's my sense that we're quite a bit ahead, and I think that's because of investments in programs like NASP. I think somebody commented earlier relative to the competitiveness of this country in aviation at the turn of the century. And I think today it's healthy because of what was invested a decade and two decades ago. And I think that's what we're talking about in the NASP Program.

There was an international conference down in Florida some six or seven months ago, and we had a number of internationals there, and there was a lot of enthusiasm to participate in some way; they were searching with the U.S. And from what I read, and talking to them, and listening to their papers, I clearly got the sense that they've got a lot of enthusiasm for a program like this; but they feel right now — they recognize that we are the leader. And I would sure support us trying to stay in that position. And I think the execution of this program is the way to do it.

Mr. **Welch**. I'm not sure what metric that you can use in terms of a leader/follower, but certainly if you take the fact that the United States—between the government and industrial community—has invested about $2 billion of very, very good work, that's $2 billion of very direct kind of technology—not with a lot of overhead and that type of thing on it.

Collectively, the best we're able to identify in the rest of the world, that's probably better than four times what the rest of the world together has spent, and perhaps ten times what any individual country has spent. So, don't say that spending is just the best metric. If you then go and begin to measure and have discussions with colleagues in other countries, what we find is that they have very good ideas; but they have neither put down the analytical basis, in may cases, and they certainly haven't begun to put down the experimental basis. Why, we in fact are moving to the testing this year of what would be considered full-scale type hardware, high volume flow in the slush hydrogen.

So, consequently, don't think it's something we shouldn't hold precious, but I believe that we certainly are adequately maintaining our position here. And certainly with the help of this committee, has both pulled and pushed us very nicely in that direction, and we hope we are responding to you.

Dr. **Herzfeld**. Mr. Lewis, I agree with my colleagues. I think we're clearly the pace-setters in all of the main technologies that are involved. That's really the way to tell. There's no one even close as far as I can tell.

Mr. **Lewis**. I delivered a paper about three months ago in London at a NATO conference on the NASP, and there was a lot of surprise with a lot of our foreign competitors as to where we stand as to where they stand. Not so much in the dollar viewpoint, but in the progress and the goals that we've been able to establish. And one of the greater surprises, of course, was the consortium that was formed amongst competitors to help develop this thing.

Thank you very much for your observations, thank you very much, Mr. Chairman.

Mr. **Valentine**. Thank you, sir.

The Chair will recognize at this time the gentleman from Maryland, Mr. Gilchrest.

Mr. **Gilchrest**. Thank you, Mr. Chairman. What I'm going to ask I hope has not been asked prior, so I ask your indulgence on that. We're talking about revolutionary technology, so I guess when we're using those terms the potential value of this goes beyond what we can speak to this afternoon. And what I'd like to do is ask if we can have some vision, and I know some of it is referenced in your testimonies, some long-range military utility to this particular program. And Mr. Rohrabacher made reference to this a little bit earlier, but I had to leave, is there any plan—or in this visionary technology—so that this particular vehicle could takeoff, dock in a space station, and then go on to the moon, and then come back to earth? Is that something that's needed, necessary? What's the civilian commercial value of this particular product? I just have two more. Maybe I should stop and then—I have two more quick questions, but if you could respond to those.

Mr. **Welch**. My first response would be just a note of caution when you said space vehicle. I think perhaps while you were gone we called attention that this is a research vehicle, an X-vehicle meant to lay in the foundations.

Now, once moving beyond that I think that as you look at the type of military capabilities that are strategic command, looking worldwide, and the aspect of how we have seen much more of the military contribution by effectively using space as represented by U.S. Space Command, I think they're quite unlimited. I think they will only be limited, truly, by our ability to demonstrate and sufficiently reduce the risk that would cause a military commander to say, "I can expect to have that at a certain time." I think that's the way to look at this vehicle right now. We're moving into technology base. We're moving into risk reductions. We're providing those foundations where the military commanders can, in fact, begin to lay down their needs.

We have in the Air Force said that in a need statement you can put invention. In a specific requirement that you want delivered for a certain number of dollars at a certain time, we can't have any inventions. I think that's the best way to relate that. We can work with the inventions to date, and we're laying this foundation.

The second part is you have a little revolutionary. We see today the beginning of some rather strong result from the work. I would give you in the military area the higher temperature, long-endurance type of structures that we see in some of our air vehicles that are in development today are benefiting directly from the computational fluid mechanics work that was done in the NASP Program.

I think if we move out of the military, I know that people are beginning to talk about titanium matrix prosthetic joints for replacement in the human body. Those things can be thought of as today.

So, I would put you in kind of two eras of revolution, perhaps. That which is represented by NASP in it's single- stage-to-orbit, and that which is also represented in the military and civilian world and private sector that will come as we make our way along.

Mr. **Gilchrest**. Sounds pretty—to use Mr. Spock's words —"fascinating." He's in a different business. Two hundred years from now, I guess. I'm in full support of this, and I do find it all extraordinary. And I guess the infinite potential of these types of improvements are a natural part of human questing for new knowledge and new things and it's probably also inevitable. So if we don't do it, the Japanese or the Germans or somebody else would do it, and the spin-off technology, I guess, is what's going to be to our advantage as far as competitiveness is concerned.

Just one last quick minor question—and I know I can't say "vehicle" because it is in the research stage—but when this thing, this aerospace vehicle takes off, like Mr. Rohrabacher said, it goes to Vietnam and back. Can it go to Vietnam and back without refueling? Would it need to be refueled in Vietnam?

Mr. WELCH. I would think that that's probably a specific question beyond what we've looked at. But I can assure you it is going to have to be refueled at the other end. I think the operational aspects of those things and the handling of the fuels that go in here—and I would say we are, in fact, involved in the environmental impact statements, and that kind of thing which must accompany all of these. So, certainly, I would think that we would be looking for fuel before we came back. But we're at the very beginnings to making sure we understand that.

Mr. GILCHREST. So then I guess you can't answer the question whether it can dock in a space station at this point. Is that something that's in the design?

Dr. THOMPSON. I would just comment, I could see where a second generation X-30 type of airplane or some follow-on NASP or X-30 derivative I believe would be docking at a second generation space station. That's not the space station that we're talking about today, but I think that's going to be a long-term program, as is this, so I would see a tie at some point probably in the front half of the next century.

Mr. GILCHREST. Thank you. Thank you, Mr. Chairman.

Mr. VALENTINE. The Chair recognizes the gentleman from California, Mr. Dana Rohrabacher.

Mr. ROHRABACHER. Thank you, Mr. Chairman.

I guess it seems after listening to the testimony that everybody agrees this project is vital to maintaining American predominance in the aerospace industry. And everybody agrees that this project will bring down the cost of getting weight into orbit or sending something into low earth orbit; thus, will open up a new door into a new era of space commercialization and the potential use of space.

We also are agreed that the spin-offs are already helping American industry, and already playing an important role in keeping our aerospace industry competitive.

What I think is fascinating today—and what today we see as a breakthrough in an area which I didn't think was going to happen today—but it is fascinating to see it and it is interesting to relate that this happened just after Desert Shield, or should I say Desert Storm, and that is that up until this moment I have never heard any support for this project coming from the Department of Defense. I just think this is manna from heaven as far as I'm concerned. I can remember some administration officials, who will remain nameless, telling me that this project has absolutely no military application; NASP will have no military application. And I remember saying to this very important individual, you mean a plane that can take off from the continental United States and bomb Colonel Qaddafi and return in time for lunch has no military application? I mean, what are you talking about?

All of a sudden now there is a reversal and I think it might be that up until the success of our troops and our military operation in the Gulf, that perhaps there have been some people who have been a little bit hesitant about suggesting that we could develop and spend our money developing such an efficient weapons system that would play such an important role for America's defense.

So, first of all, I just would like to congratulate Doctor Herzfeld, and I know you're a newcomer, but I would like you to send the word back to your friends at the Department of Defense that we are very pleased that they finally acknowledge this project does perhaps have some military significance.

What I would like to do is focus on that area because the other testimony we've heard—where I believe it is interesting, it's important for the public to know—I don't think people have been candid about just how important this could be 25 years from now if we develop the NASP and we have vehicles that are second generation that we could actually defend this country from bases in the continental United States, could we not?

Dr. **Herzfeld**. That depends somewhat on the threat, Mr. Rohrabacher. But sure, it would even the odds against some threats. It may not, however, be the most cost-effective way to do that job. As anyone who has studied my views over the years knows, I am in favor of defensive systems. I haven't thought of the NASP in that context, to be honest, but more in the offensive and looking around mode, but you may have a good point. I'll go off and think about it.

Mr. **Rohrabacher**. The National Aerospace Plane might even bring down the cost of putting up the Strategic Defense Initiative, might it not?

Dr. **Herzfeld**. Possibly.

Mr. **Rohrabacher**. If you were going to put your money on a fighter airplane that can go two times the speed of sound versus the NASP that's going ten times the speed of sound, who would you bet on?

Dr. **Herzfeld**. That depends on what the vehicle is for. There are lots of applications where the speed of the platform is not as important as the speed of the weapon, for example. But there are lots of things to think about if one has a very fast platform; you're quite right. And, if I may say, I don't think I am the first witness from the Department of Defense to support NASP. I think Mr. Welch has been doing so for quite a while, and I am just following in his footsteps in a certain sense.

Mr. **Rohrabacher**. Well, I cannot tell you how frustrated I have been with the lack of aggressive support by the Department of Defense, which I would expect, because common sense tells me that when you get a craft that can take off from the continental United States and fly anywhere in the world in an hour and could possibly be a weapons system as we go into the second and third generation, that this has no implication for the security of the United States. I happen to believe that developing technology in order to protect our national interest and to promote the security of the United States and to preserve world peace, why, that's a very good investment. So I know Doctor Welch would like to comment on that.

Mr. **Welch**. I would simply say that we're talking about timing. I think where perhaps you have seen what you interpret, and, in fact, is some reluctance is as to when it could be happening. I think everyone has been rather together on the ability to have horizontal take-off and land, single- stage-to-orbit, et cetera. I believe where in previous years we've maybe had a different level of enthusiasm as to when it could be had, and I think perhaps over the course of the next year we will have an opportunity to know how much it will cost us to have it also. And I suspect we'll have a good discussion on that also.

Mr. ROHRABACHER. Well, I think that perhaps after Desert Storm that people aren't quite as timid talking about building very efficient weapons systems, and I am very happy to see that. But that is not to note that just building this as a weapons system is a justification for this project. I think that the real gem of the National Aerospace Plane Program is that we are developing technology which will improve America's position both for our competitiveness and in our utilization and commercialization of space and also a system that could well be used to protect the United State's national security and preserve the peace. Doctor Thompson, if you'd like to comment on that, you're certainly—you've just been there, so.

Dr. THOMPSON. No, I would certainly share your enthusiasm. I do think we're several generations off. You know, we're talking about whether it's an unmanned payload or there are people in this thing. It's going to be bathed in hydrogen. And there is an awful lot of work to be done.

I think as I commented on it this time last year and you and I got into some discussion, I personally believe that this program has a lot of merit if there never was a military application, although I will yield to others in terms of divisions in that direction; nor if it never really works as a commercial airliner in that sense. I think it is going to drive so many technologies in other directions—in aviation, in space technology—that it is going to be worth every penny that we've invested in space. But I would not be shortsighted. I think once you get this thing off the runway, it is going to have a lot of utility.

Mr. ROHRABACHER. I would say, and I will agree with you, that it is visionary, but sometimes in order to create things 50 years down the road we have got to start on the first couple of steps. It would be the same way that it would be visionary to state the Wright Brothers what they're doing is perhaps something that could lead to a 747. And I believe somebody back there probably had the vision to say that someday there will be a 747 that will be jetting people to different parts of the world and play a major role in commerce between the nations and bring the world together. It is just that type of vision. Plus the willingness of people to set their goals beyond next year's budget deadline that really helps create a better future and creates human progress. And that's what this committee is supposed to be all about.

Thank you very much, Mr. Chairman.

Mr. VALENTINE. Thank you, sir.

Thank you gentlemen very much. We will reserve the right to afford an opportunity to subcommittee members who are here to submit questions to you if they desire, and if you would answer those at your earliest convenience, we would appreciate it very much.

We do thank you for the time and effort that went into preparing to be here and for coming and sharing this information with us. I must say in reference to Mr. Rohrabacher's statement and his application of this technology, as an old tailgunner on a B-24, this is pretty strong stuff to think about a defensive aircraft or any kind of weapon that moves this fast, it would have to release its — if it was going to bomb the gentleman we just dealt with in Iraq— release the bombs when, when he left the coast of the United States?

[Laughter.]

Of course we'd drive it as fast as we could and then slow down, I suppose, to do the work when you got there.

Well, thank you all very much.

Mr. **Welch**. Thank you very much, Mr. Chairman.

Dr. **Herzfeld**. Thank you.

Mr. **Valentine**. The next and final consists of Dr. Robert R. Barthelemy, who is Program Manager, NASP Joint Program Office, of the U.S. Air Force; and Mr. Barry J. Waldman, Vice President and Program Manager for NASP Program, Rockwell International Corporation.

Welcome gentlemen. If you could summarize, your prepared statements will appear in the record as presented to us. We appreciate your appearance.

Dr. Barthelemy, please proceed.

STATEMENT OF ROBERT R. BARTHELEMY, PROGRAM MANAGER, NASP JOINT PROGRAM OFFICE, UNITED STATES AIR FORCE

Dr. **Barthelemy**. Mr. Chairman, gentlemen. We're going to break up the statements in two parts. I am going to cover the technical progress that's been made in the program over the last year since we briefed you last time, and Mr. Waldman, who is the director of the contractor team, will talk about the management structure that we've just put into place, the new teaming arrangement, and our plans for fiscal year 1992 and fiscal year 19993 program.

Let me focus on two areas: First of all, the design of the airplane. If I could have the first—I guess it is a little bit difficult to see— but what you will see on the viewfoil are three airframes that we showed you last year. Although you might not have all seen those, they are extremely different from the model that you see on my left. I think you can begin to see them come into focus here. Those were the three approaches that our three airframe teams were taking prior to the teaming. And although all of them had a significant amount of merit and we felt very comfortable about their ability to satisfy the goals of the program, now that we've teamed and we've looked at the best features of all three of those and we synergistically put them together into the model that is on the next viewfoil, we find that this one is significantly better in terms of its robustness, in terms of its performance features, and probably most importantly because it now utilizes the technology that we feel is going to be available for the Phase III program.

We've looked at some technologies; some of them have worked out, some of them haven't, and this new design utilizes those technologies we feel will be coming to fruition at the end of the Phase III program. It is hard to tell from a picture like this or from a model that you have here in the room, but the front end of this airplane, the front bottom end, really came from some ideas of one of the airframe contractors; the middle part came from another, and the back end from the third. The engine, which you really can't see at all, has some features of our two engine companies. And when we combined all of this—and it took some time, it took about six months before the synergism really took hold—we now have an airplane which has significantly better performance than any one of the ones we had prior to this time. So I think that's a strong statement for bringing the best capabilities of this country together and getting the very best product.

It is a plane that looks different from anything you've seen and I think it utilizes the air-breathing engine performance to its maximum. That's something that's always been the focus of this airplane and also the focus of the program. And although you can't see it, the materials that are involved here are the kind of materials that we've been testing and developing over the last three years and will continue to develop. So I think that part is very important to this program, and probably more importantly because the airplane design is the focus of the program. We now have a single design to focus this program which will better utilize the funding in 1992 and 1993 to develop the technologies.

I would like to go on to the second part of my remarks, and that is the technology. Now this looks like a piece of corrugated metal—and it is, you can tell a little bit of its size from the individual that's in the back—but this is titanium metal matrix composite with small silicone carbide fibers that hold together probably the most advanced titanium alloy that we're going to be coming up with in this development activity. The significance of this is that this represents a part of the fuselage of the airplane. This is just a demonstration and a test model, but you can see already that if you made this a little bit bigger, it would begin to look like the fuselage of an airplane. What's significant is that not only have we tested TMC, titanium metal matrix composite, to the kind of temperatures that we feel the plane will encounter, but we've built now structures that look like the airplane. So we've advanced beyond what we call the coupon testing phase of this program to where structures can be built.

What is even more important that you can't see on a picture like this is that we're beginning to create an industry in the United States, several people who can manufacture this material, who can build structures out of it, and that's extremely important in terms of the technology transition of these high temperature, very advanced materials to businesses like the automobile industry and energy industry and even to the biological industries. That's important because the spin-off of this program is already beginning to take place by the creation of these new industries.

The next one shows a picture of the tank that we're going to be inserting, is actually inserted into that titanium metal matrix composite structure. The significant part about this picture I think is the fact that it is extremely light weight. We're talking about a tank here that will hold the slush hydrogen that will be in the airplane. You can just tell from the demonstration that it is very, very light weight. So we're talking about an airplane and the materials that go into that airplane that are significantly lighter than anything we've looked at before. The feasibility of this whole concept of a single stage-to-orbit vehicle depends on extremely low weight, high performance materials, and that's what's happening over here.

Now, the next one is both a success story and a failure. As Mr. Welch mentioned, there are going to be failures in a program like this. We are going to go after things that we can't achieve. This happens to be something called gamma, a particular type of titanium aluminum alloy. And although we've built this material and we're welding it over here, you can see that it could be used for a large structure. We were hoping though to get this material in such a capability that we could use it in the engine. We were not able to do that. The compatibility with hydrogen and the stresses put a material like this does not allow it to be used in the engine. Well, the good news is that we were able to get other materials for the engine and we've now designed the engine using those other materials that we feel we have much more confidence in, and that engine performance is as good as when we were going to use this material. So there are going to be these kinds of things that don't pan out in a program like this. On the other hand, we're going to use some of this material perhaps for the heat shield of the structural part of the airplane.

So throughout this program, and certainly in the next couple of years when we're still in the developmental phase of the activity, we're going to see things that do happen like we've predicted and other things that don't. But the good news is that we started with a number of options and those options still allow us to pursue the kind of performance that we see in the X-30.

The very last one was just an idea of the 1992 activity. I just want to support the fact that we are putting the money that we're going to be spending in 1992 on the kinds of technologies that we need to develop. The air-breathing engine technology, the critical technology that you heard from J.R. Thompson, Mr. Welch, and everybody up here is getting the bulk of the activity in fiscal year 1992, and so we're moving in that direction. Materials and structures are a very important area, commanding about one-fourth of the funding.

Fuel systems, slush hydrogen, I can report to you that the progress over the last year really gives us tremendous confidence in the ability to use slush hydrogen. We've made a lot of it, we've pumped it, we understand it much better, and we're going to go with slush hydrogen as the fuel. That was an uncertain area before this year and I think we're much more confident about that decision right now.

And then test facilities which will benefit not just the NASP program but the aerospace community in general, something that we, as a country, have not spent enough money in and that the NASP program has had to carry as it's gone along.

So, as you can see, we're putting the resources that we have—and this actually represents the people resources as well as the money resources—on the critical technologies; the air-breathing engine technology, our foremost challenge and the one that we want to bring home in the next couple of years.

So let me conclude there with that very brief activity progress report and tell you that the program is on track. We're meeting the milestones that we set for ourselves. The technology is reaching the kind of fruition levels that we were hoping. And we've already begun to spin-off that technology to other areas in the aerospace industry as well as to other industries.

Thank you.

Mr. VALENTINE. Mr. Waldman?

STATEMENT OF BARRY J. WALDMAN, VICE PRESIDENT AND PROGRAM MANAGER, NASP PROGRAM, ROCKWELL INTERNATIONAL CORPORATION

Mr. WALDMAN. Thank you, Mr. Chairman and members.

I am up here today speaking for the National Contractor Team. And since I've never heard any of their names mentioned during the testimony so far today, I would like to do that. The companies are General Dynamics, McDonnell Douglas, Pratt and Whitney, and the North American Aircraft and Rockedyne Divisions of Rockwell International. Those are the five members of our team.

The testimony that I submitted dealt with the technical and management progress of the program, and Doctor Barthelemy has summarized the technical progress, so I will talk to you about the management portion. I would like to make three points as I do that. The first point, as you have heard repeatedly so far today, is that the contractor team is working. We have established an entity that we refer to as the National Program Office, or the NPO, which is an office composed of members of all the five companies empowered by the senior executives of the five companies to have the authority to make the decisions and manage this program on behalf of the entire consortium. That team is in place and we are under contract now, so we are in control of the program and have been in a contractual sense for something just over a month.

We have also achieved something that is integral to the entire concept of the operation of the National Team, which is distribution of the workload of the program. Something that we've learned as we've been proceeding on the program is that it is equally important to distribute leadership as it is to distribute work. Those two principles have played a large role in the formation of the management concept that I believe we are evolving and someday may be a model for other consortia of this type.

We have at the National Program Office a series of deputy directors who report to the director, in this case myself, who are provided by members of the entire team, and they all have assignments that span the activities of the entire team. So they operate for the team, not for their home companies. Even the program managers who manage the work going on at the five distributed sights also have responsibilities which make them responsible for portions of the team activity as a whole. And so among all of the members of the senior leadership of the program, we have people who are responsible for activities that cut across the entire activity of the team, giving them ownership of the entire product. I think that that principle is standing us in very good stead with respect to the progress that you have heard that we're making.

We have achieved a unity of purpose. We have paid very close attention to all of the motivating factors that are inherent in the coming together of five traditional competitors and, on this program, historically intense competitors. By being certain that we understand what are the forces that cause people to act the way they do and managing those, we have achieved a synergy and, as I said, a unity of purpose among the team that is contributing very strongly to our progress.

The second point is that there is another team at work here which is the government-industry team. We are working very closely with the Government. We are operating in an environment of openness and trust that I would say probably has no precedent in our type of business. We are working jointly and producing products jointly in areas where, in the past, it would be accurate to say that neither of us would have even given visibility to the other, let alone shared participation. So that team is working very well also, as evidenced in large part by something that we refer to as Government Work Packages. There is a core of hypersonic expertise resident in the Government, in its laboratories, in its centers, that has been in place and has been developing hypersonic technology for decades, and to not make use of that would be literally a crime. We are making use of that capability within the Government. We call it mainlining the Government, and their activity on behalf of the program is as integral to the program as is the activity of the contractor team.

The third point is that we have a solid plan in place now for the next two years. We have started what we refer to as contract Phase II-D, which is the phase under which we are operating under a single contract to our joint venture. We have amalgamated all of the concepts that existed before teaming into the design concept that was described earlier by Dr. Barthelemy, and we have an integrated plan that incorporates the Government Work Packages. Our plan for the next two years is focused intensely on what are called the exit criteria for Phase II, the demonstration that we are technologically ready to proceed at acceptable risk into Phase III, or the development and flight test of the X-30. We are focusing on the design, on the propulsion, on the structures, and on slush hydrogen. As we perform the work of Phase II-D, we will be achieving substantial validations in each of these areas.

So in summary, from a management sense, our joint venture has been formed, the team environment has been created, National Program Office is in place, work is distributed, our plan is complete. We have demonstrated our ability to step up to the tough technical decisions. We were able to sort through the previous competitive designs, make the decisions that lead to this integrated airplane that we're all very proud of. You've already heard some of the description of what this represents compared to its predecessors. So the bottom line I believe is that we're demonstrating that complex consortia of this type are workable. That in situations where consortia are the right way to go for the country, I think we're demonstrating that American companies can pull together and produce the quality of work that you expect of us.

Thank you.

[The prepared statement of Mr. Waldman follows:]

NASP
NATIONAL PROGRAM OFFICE

REPORT ON THE PROGRESS OF THE NASP PROGRAM

PRESENTED TO JOINT AUTHORIZATION HEARING

HOUSE SCIENCE, SPACE AND TECHNOLOGY COMMITTEE
SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS

HOUSE ARMED SERVICES COMMITTEE
SUBCOMMITTEE ON RESEARCH AND DEVELOPMENT

MARCH 12, 1990

PRESENTED BY MR. BARRY J. WALDMAN
PROGRAM DIRECTOR
NASP NATIONAL CONTRACTOR TEAM

It is a pleasure to be given the opportunity to describe the progress that the National Contractor Team has made. In both the work accomplished prior to teaming, and especially the work that has been accomplished since forming a national team, we have made great strides toward making the X-30 a reality. This report describes some of that progress, in both X-30 design and technology development. It also describes the unique management structure under which we are proceeding forward as a National Contractor Team. Finally, this report concludes with a discussion of where we will be, in both design and technology development, at the end of the present phase (Phase 2D) of the National Aero-Space Plane Program. It is at the end of the present phase that we will be seeking permission to proceed with detail design and development of the X-30. The team is confident that we will be able to demonstrate both our readiness to proceed and that we can, indeed, achieve the ultimate goal of Single-Stage-to-Orbit with a reusable vehicle powered by airbreathing engines.

PROGRAM PROGRESS

The NASP team has made significant progress in refining the X-30 design and developing X-30 technology in both the competitive phase of the program and since teaming. In the following, advances which we have made in both parts of the program will be described. It is useful to begin with our design progress, since that represents a significant portion of our activity following teaming.

Prior to teaming, each of the airframe contractors had developed a configuration concept for each of the competitive engine designs: there were thus six concepts for the X-30. Each of these had different strengths and weaknesses that arose from the different ways each contractor had approached the X-30 requirements. In fact, it was our growing recognition of these differences, which made it evident that no one of the contractors had all of the answers to the problems posed by the X-30 requirements, that was one of the reasons for forming the team. Our challenge, following teaming, was to create a new design concept which embodied all of the strengths and none of the weaknesses of the competing concepts.

Recently we completed the first design cycle as a team in the development of our design concept. While the exact details of the team concept and the earlier independently developed concepts are classified, this design does not look like any one of the preceding designs but incorporates features from them all. For example, the shaping of the nose region derives from one concept, the wing and tail layout from the second, and the exhaust nozzle shape from the third. Similarly, the engine concept combines the airpath layout from one of the competitive concepts with the combustor and structural design approach from the other. Many other features of the team concept for the X-30 which are not apparent from an external view also derive from the best features of the competitive designs, including structural concept, tank design, and leading edge cooling technology.

The design of the X-30 is not, however, simply an amalgamation of features. An airbreathing hypersonic vehicle, and particularly one designed to fly from a runway directly into orbit, is very highly integrated, and each of its features interacts directly with all of the others. Thus the best combination of features is not in general a combination of the best features, and design of the vehicle can proceed only through a series of analyses that treat the design as a whole. These design analyses are complex and time-consuming. One of the immediate indicators of the success of teaming is the speed with which these integrated design analyses can now be completed, because of the vast experience available to all of the team members through the resources of the team as a whole. This has cut the time required to develop the new X-30 concept considerably compared to pre-teaming design turnaround times, and has allowed us to quickly get to a point at which the predicted takeoff gross weight of the team X-30 is nearing our design goal, using materials and fabrication techniques which can be available to meet the X-30 schedule.

There are a variety of other ways to measure design success. For many of these parameters, which include volumetric efficiency, structure fraction, drag coefficient, and aerodynamic stability coefficients, the team X-30 is achieving in combination the values achieved singly by the best of the competitive designs. The results of the synergism of teaming are also being seen in the team engine design, which combines high performance and flexibility with a structural concept which allows full-scale testing in existing ground test facilities.

One of the reasons we have been able to progress rapidly as a team is the experience and confidence that we have built up during the competitive phase of the program. This experience base involves both design and technology, and the success of the NASP technology development program is rapidly increasing our confidence in being able ultimately to reach the goal of SSTO capability. For example, in the key area of propulsion technology we have successfully tested one-seventh to one-quarter scale engines to Mach

8, and full-scale propulsion components to Mach 6. Each of the pre-teaming engine development programs included subscale integrated engine testing, in which a complete engine design - air inlet, combustion chamber, and exhaust nozzle - is tested as a unit in a high-speed airstream. Both designs demonstrated performance levels that - when extrapolated to full-scale - met X-30 requirements at both Mach 6 and Mach 8. Both also tested large-scale engine components at Mach numbers as high as Mach 6, with one obtaining test data on a complete full-scale engine module from static conditions to Mach 2.7. Coupled with this extensive test program has been the parallel developent of advanced computational fluid dynamics (CFD) techniques for the analysis and interpretation of the experimental data. Since at high Mach numbers, ground test facilities can only simulate, and not completely reproduce, the physics and chemistry of the actual flight condition, advanced CFD methods are necessary to determine accurately flight performance of the X-30. The development of these CFD methods itself represents a major technological advance driven by the NASP program. Although there remains much work to do to fill in the test envelope and demonstrate other aspects of the propulsion system, the work already completed demonstrates that the engine performance required by the X-30 can be achieved.

Propulsion is one of the two key areas where the technical breakthroughs required to meet the X-30 requirements are being made. The other is materials. Meeting the performance expected of the X-30 will require materials which are lighter and stronger at higher temperatures than conventional materials. Fortunately there are a number of material systems of promise - but when this program began few of the promising systems existed in quantities sufficient for property data determination, let alone construction of major structural elements.

Recognizing the need for new materials, the efforts required to get them ready for use in the X-30, and that no one contractor had a competitive advantage in this area, the NASP contractors formed a consortium for materials development early in Phase 2 of the NASP program. This consortium was in some ways a precursor of the current team, and it was highly successful. Each contractor took lead responsibility for one material system, supporting the other contractors on materials for which they had lead responsibilities. All of the major material systems of interest were included: advanced titanium alloys such as titanium aluminide, metal-matrix composites in which fibers of silicon carbide or graphite are embedded in titanium aluminide or copper, and refractory composite materials such as carbon-carbon or carbon-silicon carbide. The success of this consortium can be expressed by the fact that for several of these materials the normal fifteen-year cycle between laboratory experiment and structural fabrication was compressed to only four years.

Titanium-based materials have been the subject of considerable development work under the NASP program, including both advanced titanium alloys and titanium/silicon carbide metal matrix composites. High strength at low density and at high temperatures are characteristic of these materials, with titanium metal matrix composite having a specific strength (strength divided by density) some fifty percent higher than that of a conventional titanium alloy at 800°F and a specific strength at 1500°F equal to that of a conventional titanium alloy at 900°F. Considerable progress has been made as evidenced by the fact that whereas only test coupons of these materials existed at the start of the NASP program, and fabrication techniques were unexplored, the NASP contractors have succeeded in producing large complex fuselage and wing box structures of titanium metal matrix composites. These structures are now being tested to learn more about the fabrication methods for these advanced materials.

These titanium alloys also represent an early spinoff area for NASP technology. As one example NASP requirements have led to the development of an alloy known as Beta 21S, with improved properties at high temperatures. The attractive properties of Beta 21S are also of interest in orthopedic implants. Thus this alloy is currently being evaluated by the FDA as a material for hip joint implants. Because of its greater corrosion resistance than other alloys, it reduces the body's exposure to toxins and it is more compatible with bone, promoting bone growth and attachment onto the implant.

Carbon-carbon composites are a more mature materials system than the titanium materials. They are used, for instance, on the Space Shuttle wing leading edges and in certain exhaust nozzle applications, but these materials still require additional development to be used on NASP. In particular, NASP use of carbon-carbon requires the development of suitable protection against oxidation at high temperatures and bonding and fabrication techniques necessary to produce large structural components. NASP team members are doing extensive work on the fabrication of large structural components using carbon-carbon with an oxidation-resistant silicon carbide coating. This effort has produced the largest section of structural carbon-carbon so far fabricated. Like the titanium metal matrix wing section, this carbon-carbon structure is currently under test to determine its behavior under combined thermal and pressure loads.

MANAGEMENT

The organization of the NASP program can be looked upon as an approach which is, in its own way, nearly as innovative as the X-30 itself. The joint venture which the five prime contractors have formed is a response to the government's interest in creating an efficient program which maximizes contractor involvement. Compared to a competitive program, the interests of efficiency are served by avoiding redundant parallel development, which is especially important when so much of the needed technology is on the "critical path". With the contractors all participating in a single program, there is a much better chance of achieving the breakthroughs that are required to make the X-30 a reality - because of the focus that the team can provide and the breadth of experience of the team as a whole. This experience is further enhanced by the technology base within the government laboratories, which can be made available to the contractors without fear of giving one or another an unfair competitive advantage. From the contractors' viewpoint, an additional advantage of the team program is that each contractor will gain the expertise to be fully competitive in any follow-on hypersonic vehicle program.

The NASP National Contractor Team is based on the concept that its five members - General Dynamics, McDonnell Douglas, Pratt & Whitney, and the North American Aviation and Rocketdyne Divisions of Rockwell International - are each equal partners. It is important to be aware that this joint venture has as its scope the X-30 only - subsequent vehicles which may follow from X-30 technology, and parallel developments not directly derived from the X-30 effort remain competitive areas. But within the scope of the NASP program to design, build, and fly the X-30, and develop its supporting technology, all effort is shared. Note also that while each of the partners is equal, it is not true that the work is equally shared - it's unlikely that such a distribution would result in an efficient program. Instead work is equitably shared - approximately equal in terms of effort involved and such that each contractor contributes its areas of greatest strength and each develops the expertise required to be competitive on other hypersonic programs.

The National Contractor Team structure was first laid out in an Interim Teaming Agreement (ITA) signed by the contractors and submitted to the government for approval on January 22, 1990. While awaiting approval, the contractors, still maintaining their competitive posture with respect to their contractual activities, began joint planning to determine how best to move from a competitive program into a team structure. Government approval of the ITA on May 25, 1990 moved this effort into high gear, with the immediate exchange of technical data and establishment of a National Program Office (NPO) in Seal Beach, California, to lead the team. However, each contractor retained its individual contract until January 30, 1991, when the government issued a single letter contract to begin the Phase 2D effort upon the receipt of a fully executed formal Teaming Agreement (TA) entered into by the five prime contractors for the duration of the NASP program. The team's progress is especially significant when compared to the short time that has elapsed since we first exchanged technical data.

The National Program Office serves as the integrator of the NASP program across the five prime contractors. It is the single point of contact for the government with respect to contractual and technical matters. The NPO Program Director has reporting to him a total of seven Deputy Program Directors, each of whom is responsible for coordinating the activities of the five prime contractors in specific areas which include both programmatic and engineering functions. Each of the prime contractors' Program Managers also reports to the Program Director in order to integrate the total work on the program. The Program Director reports to an Executive Overview Committee, made up of senior corporate executives of each of the five prime contractors.

Smooth functioning of this National Contractor Team requires a considerable degree of trust among the team members, and this trust is rapidly being established. Given the intensity of the competition that preceded the formation of the team, a certain amount of time was needed, but that technical progress has been shared and each contractor has grown to appreciate the work and capabilities of the others. After an initial period of absorption of all of the data that had been developed by the members of the team, progress began to accelerate, with respect both to design and technology development, and by now all of the members of the team agree that the technical quality of the work being done on the X-30 has been enhanced.

PHASE 2D PROGRAM PLAN

With the effort of teaming behind us, we are now embarking on the last part of the technology demonstration phase of the NASP program. This Phase 2D effort is aimed at satisfying a set of criteria by which we will be measured with respect to our readiness to

Mr. **Valentine**. Mr. Waldman, does this industry teaming have advantages? Is there a lesson there that we should pursue, in your opinion, in dealing with other projects?

Mr. **Waldman**. Well, let me first address the advantages that teaming has had from the standpoint of this program. In the period before teaming, the design concepts from the five companies had pretty well stabilized and innovation had been achieved earlier but the focus had become one of maturing the concepts that existed. One of the results of teaming is that we've had a reinvigoration of creativity in our design. So we've had an immediate benefit there.

As the program matures, we will also see the benefit that the country will end up with five fully qualified competitors for future hypersonic programs. And that was one of the goals that the Government had in initiating the teaming process. And so you will see that.

Now, when the right dynamics exist, the question is could this be a valid way to go on other programs, and I think the answer is it might and that would depend on the specifics of those other programs.

Mr. **Valentine**. Soon after I became acquainted with this project, I began to hear discussions as to whether or not the simplicity of design would be compromised through the evolutionary process by attempting to address the other needs — such as safety and—in other words, whether we would begin to put leather upholstery in this thing before it was necessary. What do either or both of you say with respect to the simplicity of this vehicle. I am told that while we should be concerned of course with the safety of human beings, that there will be a long line of pilots ready to fly this thing. When you do things that would enhance the safety, you do things to slow it down. Would you talk a little bit about that, perhaps Dr. Barthelemy.

Dr. **Barthelemy**. It is kind of interesting because we're just going through another design cycle of that very model that I talked about and that you see over here. One of the issues that we're looking at is how do we work in robustness and safety and some of those other issues, because, obviously, there has to be some robustness, there has to be some safety features. But you know, this airplane is such an advance in the state of the art that the simplicity aspects have to be retained, there is just no question about it. The engine, for example, is predominantly an air-breathing engine. We'd like it to be all air-breathing and that's what our goal is. And in order to achieve that, it has to have extremely high efficiencies and very low drag. So the simplicity is kind of inherent and we have to maintain that, we can't compromise that; otherwise, there is no point in building the airplane. That is going to be our fundamental philosophy.

Once we get to an airplane design—and we're there— that we really feel we can achieve the performance goals of the airplane, then we have to look at robustness and we can work that in. That's going to go on over the next couple of years. But there certainly has to be a certain amount of robustness and safety because you wouldn't want to compromise either the pilot or the plane in the flight testing.

This is a balanced program, and the good news is that it is an X-vehicle program, which means that there are going to be risks, certainly, and there are going to be margins that we have to account for, and there is going to be no assurance that everything will go right on the flight. So we've programmed for that; we've laid out a test program that can accommodate that kind of a philosophy.

Mr. **Valentine**. Doctor, what is the status of the Government baseline update study?

Dr. **Barthelemy**. It is underway, the study is underway. We ran into some difficulties in contracting with one of the contractors that we needed for that. That lost us about a month-and-a-half. We would have like to come back to you in the middle of May or so with a report; it looks like July will be the time period that we can come back. And that was mainly due to the late start of the contractual effort.

Mr. **Valentine**. And finally, Doctor, let me ask you if you will tell us what, in your opinion, are the technology problems.

Dr. **Barthelemy**. Well, I guess I'm just going to parrot what has been said before. The air-breathing engine is probably our biggest challenge. The good news that I didn't mention is that we've tested a full-scale engine all the way up to mach 6, and that is the limit of our ground testing capability. We're going to be testing a multimodule test very shortly to look at the impact of one engine versus the other engine in flight. We're going to be testing small scale engines and totally integrated engines all the way up to the mach 20s or so. So we've planned out a very vigorous and challenging test program to understand the air-breathing engine, but it is certainly the key fundamental technology. We still have all the confidence that we're going to be able to make our goals. That's our key one.

I think if you had asked me last year is the materials area was as big an issue as the engine, I think I would have said, yes. This year, I won't. I think we've brought home some technologies to the point, as the viewgraphs displayed, where we're now building structures out of the very materials that we may be using on this airplane. We've got two more years to really test these out and put some meat, sort of, on the skeletons of what we understand. But I think we can do that. So in second priority will be the materials activity.

And then even better news I think is the fact that the slush hydrogen, which is really needed for a vehicle like this, is coming along very nicely. And our Government work, that mainly is a Government activity, is doing very well in proving out that technology for this airplane.

So it is pretty much what you've heard before. We agree with that. And, as you can see, we're spending our money in that order of priority.

Mr. **Valentine**. Thank you, sir.

Mr. Lewis of Florida.

Mr. **Lewis**. Thank you, Mr. Chairman.

I didn't get the number on your graph up there for facilities, Mr. Barthelemy.

Dr. **Barthelemy**. This coming year, fiscal year 1992, we're going to spend about $45 million in facilities. That's a heavy price for research and development program to pay. But, as you know, the facilities that we need for this program don't exist. Now they are beginning to exist and we're continuing to enhance the ones that we have. I would say though that as a Nation, we really ought to look into a much larger investment in aerospace, particularly high speed aerospace facilities for the future because hopefully programs that follow NASP—not NASP, but the programs that follow— will have a facility base to test in, and we didn't when we first started. We've made a lot of progress, but I think that's something that we owe the technology future of this country.

Mr. **Lewis**. Are you looking to doing any subcontract with any foreign countries, as far as England or—

Dr. **Barthelemy**. No, we aren't. I think there certainly are capabilities in the foreign countries that we would liked to have had here in the United States, but we have no plans at this time to work with them.

Mr. **Lewis**. How much do you think—let me rephrase it, in the facilities dollars that you're showing, do you have dollars in there for CFD advance design so that you can bring the CFD up-to-date to meet the requirements that you need for the vehicle itself?

Dr. **Barthelemy**. Yes. They are not in that particular area, but there is a significant amount of money in the CFD area. As a matter of fact, at one time when we were spread out in a competitive sense, we were probably utilizing about 50 percent of the supercomputer capability of the aerospace industry on NASP alone. That's come back a little bit. The good news is that other people are using our codes for other applications, so we've already made some technology transition there. But there is a lot of CFD work going on and that's an area that when we did an assessment last year of how far we had progressed, we were ahead of schedule. We were actually about a year ahead of schedule on that one. So there is a lot of work going on in CFD in this program.

Mr. **Lewis**. Okay. Do you visualize that you will have to have a program after mach 3, maybe in a range 3 to 6, 3 to 8, to develop inlet configuration on the vehicle itself?

Dr. **Barthelemy**. We are testing inlets at speeds even higher than what you quoted. We've got a number of inlets now in wind tunnels. We can do aerodynamic testing at higher speeds than the engine testing. So fortunately we're able to test all the way up to the mach 18, mach 20 regime, and we're looking at various inlets in that area.

Mr. **Lewis**. Okay. I have some other questions, Mr. Chairman, and I would like to do it in writing.

Thank you.

Mr. **Valentine**. Thank you. The lady from Maryland, Mrs. Byron.

Mrs. **Byron**. Thank you, Mr. Chairman. I will wear the hat of the other committee that has joined you here today.

There are several areas that we look at in Armed Services that give us a great deal of concern, and that is the contractor and the vendor base. And in this program, as we see a basic 5 prime vendors, but you've got your subs and your base there, what kind of an impact do you see on this vendor base if the program is dramatically cut back or discontinued? Are there certain vendors that you're dealing with that just specifically have ramped up for this program?

Mr. WALDMAN. For the program as it stands now, in addition to the five primary members of the partnership—you called them primes—

Mrs. BYRON. Yes.

Mr. WALDMAN. Okay. I haven't actually counted them, but we have about 15 other principal subcontractors who have already been identified as major participants in key portions of the program. There is a large network of smaller contracts beyond that, a number I couldn't even begin to tell you right now, but as an example, when we were in the midst of the material consortium, we had 150 contractors just there. So the number of very small contractors is very large.

Mrs. BYRON. And, as you know, the smaller the contractor, the more important the contract. And that's where we get ourselves into trouble a lot of times.

Mr. WALDMAN. Well, this program is very important to all of the contractors, large and small, because of the cutting edge technology that it is developing, and it is developing that among all of the participants. You talked about a cutback, if there were a cutback, it would be very damaging to all of them.

Mrs. BYRON. Do you see an application of the vendor base for a future that we can spin-off for civilian or other military uses?

Mr. WALDMAN. Yes, I anticipate that spin-offs of NASP program can take many directions. It can take the direction of NASP-derived vehicles, it can take the direction of a higher technology content in other aerospace products, and it can take the form of commercialized applications of some of our technologies. And I anticipate that it is in large part this vendor base that is going to see much of the benefit, especially of the latter two of those and largely of the first one as well.

Mrs. BYRON. I think we've seen over the years a large number of individuals coming out with advanced degrees going into programs where they put an enormous amounts of their talents and energies in that program and then that program is cut back and then cancelled. I think right now we have a great concern in this country about having the talent available for the development that we're looking at.

The potential for national security missions for the NASP when it is developed, the Air Force has an opportunity to increase their capability in this program. Would you touch on the Air Force's—

Dr. BARTHELEMY. Sure. Some of that was addressed by Mr. Welch and Doctor Herzfeld. But let me say that throughout this program we have maintained an activity called Applications and Utility. This was part of the program to look at the commercial, civil, and military utilization of not only the technology that is coming out of NASP but also the vehicle, the potential vehicles, the NASP-derived vehicles we call them. That study is on-going. We haven't definitized all the applications yet, but that will be available prior to the Phase III decision; that is part of our Phase III decision briefing or input. I think at that time we will have focused down on a final design and we'll be in a better position to look at the myriad of applications. There are certainly going to be many. That's a continuing study.

Mrs. **BYRON**. When the Air Force looks at it from that aspect, suppose the final Phase III prototype does not go through, does the Air Force have alternatives?

Dr. **BARTHELEMY**. I think as a minimum, even if the Phase III program is not approved, as you suggested, and we don't build an X-30 plane, we're talking about a lot of technologies that will find their ways into all kinds of future Air Force vehicles. There already have been some specific cases where they have already been applied to vehicles that we're building today. So I think this is going to be a spin-off path for the technologies, this applications study. We're looking at that.

Mrs. **BYRON**. Okay. Thank you, Mr. Chairman.

Mr. **VALENTINE**. Thank you.

The gentleman from California, Mr. Rohrabacher.

Mr. **ROHRABACHER**. Doctor, I will have to admit to you that every time I hear that people are thinking of this only as potentially only a spin-off, even if spin-offs would justify the whole project, that it really makes me mad, I'm going to have to admit to you that because we have a project that has so much potential here and, again, people just don't seem to see the 747 when they see the Wright Brothers airplane. And they don't seem to see what is going to be happening in the middle of the next century, and, instead, they are looking at what is going to happen to the aerospace industry tomorrow via the spin-offs. Fine. I think that's a very—I'm just saying that for those people who have sort of mentioned that as an alternative—and we've heard it several times today—let me just mention that that to me is another one of the shortsighted approaches to our aerospace industry. I hope that some people get this out of their mind that that alone is going to be making this project worthwhile. If we only do that, yes, it will have been worthwhile in terms of the money that's been expended, but it will be a terrible loss because of the potential that has been lost.

I would like to just mention that this project, in terms of the consortium that we've put together, I think it is a tribute to the fact that we in the United States aren't so in cement that we can't change and we can't do something that works. The Japanese have been out competing us over and over and over again, and quite often it is because the Japanese companies can get in a room and their Government actually encourage these Japanese companies to work together to develop products to out-compete their foreign competition. What's interesting in the United States is that quite often we've prosecuted companies for even talking to each other on the telephone in order to try to develop products that might make us more competitive. So I would like to applaud this whole program and the spirit that we've seen both at the Government level and the industry level. This is new ground and we're breaking so much new ground in many ways that needs to be noted.

I would like to ask both of you to maybe comment on the idea of antitrust laws that in the past might have kept us back, and what NASP portends for the future in terms of antitrust legislation.

Dr. **BARTHELEMY**. Well, this is an experiment—and thank you for applauding what happened. It took a year to pull this together. We did it very carefully, too. We were doing two things simultaneously, which was kind of interesting. One was as the team was forming, the Government was trying to find an entity to contract with because we needed to go from competition to a coalition. So every step was carefully measured to make sure that we weren't running into antitrust violations or whatever. The good news is that we made it through that. We now have a contract with the entity.

I think in terms of the progress, it has been very good. I think it has exceeded some of our earlier expectations in terms of speed. So I think it is going to be an example to use to see if this kind of a system works. I think it works well in R&D. And, as Barry mentioned before, if you started competing and then you can form a coalition, it is even better because then all the good ideas get sort of pulled together.

Another interesting example, which we're not studying in this case, is what happens if you start this way from the very beginning; in other words, without the competition. Maybe some other program office can take that on. But it would be another data input for you to sort of assess whether it works.

I don't think this is the sort of thing to do in all programs. But certainly in focused, very challenging R&D programs, which is going to take the brains of the country, the very best, and pull them together synergistically, I think this is the way to go. We've seen it happen here; that's a comment we can make even at this stage of the game.

Mr. **Waldman**. I would just like to add that I think in the long run that this consortium is actually pro-competition because had the Government made what we call a "down select" and chosen one engine company and one airframe company for the X-30, which is a two airplane project, when the day came for a NASP-derived vehicle, which would be a many airplane project, they would find themselves without competitors. So I think that this consortium is actually very much in the interest of competition in this country.

Mr. **Rohrabacher**. And not only is it competition internally, but also externally. I happen to think, especially in the aerospace industry, we should not lament that our foreign competitors are doing so well; we should do everything we can to make sure that we're doing better.

Thank you very much.

Mr. **Valentine**. Thank you, sir.

Another lady from Maryland, Mrs. Morella.

Mrs. **Morella**. Thank you, Mr. Chairman. I am the other lady from Maryland.

I am very impressed with what I have been reading and what I have learned about what you're doing. It is really very exciting. I am curious about whether or not there are any facilities that are not included in the fiscal year 1992 budget that you need to reach your point in 1993, that Phase II completion in 1993—any labs, wind tunnels, or whatever?

Dr. **Barthelemy**. Well, as you saw, a significant amount of money is going in to the 1992 facilities activity. We are going to have sufficient facilities to complete the 1992 and 1993 test program, that's the good news.

What we're terrified about is the fact that in 1994, 1995, and 1996, as this program goes forward, as you've stated you wish it does, we won't have the kind of facilities we need to test full-scale engines or full-scale articles. These facilities take a long time to build. It is the kind of thing that often times take ten years or twenty years, and we haven't made the up-front investment as a country to be able to test in large facilities in the 1994-1995 time period, which means we're going to have to put more of the burden on the flight test program—and that's expected in an X vehicle. But I think the time is right for the country to really assess its facility situation. That is currently going on; there are at least three studies that I know of that are going on as we speak that will come to a conclusion I think very shortly and I think you will have answers as to what should we be doing. But we're okay in terms of the 1992 and 1993 program because we've budgeted a significant amount of our money to facilities.

Mrs. **Morella**. And yet the ultimate success is going to depend on what planning is done right now for beyond that.

Dr. **Barthelemy**. Down the road, right.

Mrs. **Morella**. And as the studies come in, I know that you will be very close to that.

Dr. **Barthelemy**. Yes, we're involved in that, obviously. We obviously have a great interest in what is going to be happening.

Mrs. **Morella**. And now, at the risk of offending my very good friend and colleague to my right, you mentioned in your testimony that as you go along there are these spin-offs. Now, we're not looking at spin-offs as the only result of building the aerospace plane, but there are technological advancements and spin-offs. I am curious about the civilian ones that you've already seen. I mean, you're talking about engines for automobiles, for ovens, the light texture of the material. Can you tell us something about those.

Dr. **Barthelemy**. Sure. One of the directions that the Space Council gave us, as a matter of fact, when it reviewed the program a couple of years ago was to look at the spin-off technologies. So we've done this in a significant way. We have got about three or four people in the Program Office that devote their time and energy to do that. We've utilized all kinds of mechanisms—the Reserve Officer Program of the United States Air Force is a way of looking at how you can transition technology into the civilian area.

We have programs in the automobile industry, with the energy industry, with the fuel industries to look at spin- offs. One example is the high temperature materials. This would really enhance turbine engines, automobile engines, and allow them to operate at high temperatures—which means higher efficiency; which means less fuel consumption.

We've also worked with the hydrogen industry. There is a blossoming hydrogen industry that really will use this kind of technology, not the slush necessarily, but the transportation of liquid hydrogen fuels and the distribution of it and how you transfer it to vehicles.

We've worked with a number of small companies that do specific products that are involved in industrial manufacturing. The computational fluid dynamics is an analysis technique which allows you to predict, without building the equipment, how it is going to operate in high speed aerodynamics and things of that nature. That saves enormous amounts of money. We needed to do it for this program because we didn't have the facilities to test the equipment in, so we had to go to computational fluid dynamics. Now people are saying, well, gee, if you got by with that— and we are getting by with that in certain areas—maybe we can do it and not incur the cost of testing.

So those are just a few that we found in the first few months that—

Mrs. **Morella**. So you are satisfied that you are reaching out to utilize these—

Dr. **Barthelemy**. Well, it is never enough, but we're trying brand new mechanisms. The way to transition technology, we're finding, is through people-to-people interaction—get the guy who knows the technology with the guy who has the need—and get that transferred almost by word of mouth. So we're taking that approach. It is manpower intensive, but it works.

Mrs. **Morella**. It should also be part of a national Energy Strategy, too.

Dr. **Barthelemy**. Yes.

Mrs. **Morella**. Thank you very much. Thanks, Mr. Chairman.

Mr. **Valentine**. Thank you.

Gentlemen, thank you very much for bringing this information to us today and helping us to increase in wisdom. We hope now we have the judgment to utilize what you have brought us.

As I said to you, you might receive some questions from other members of the joint subcommittees who were not here today, and we would appreciate it if you would respond to those questions. Thank you very much for your attendance here.

The subcommittees are adjourned.

[Whereupon, at 4:10 p.m., the subcommittees adjourned, to reconvene at the call of their respective Chairs.]

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